ACTA UNIVERSITATIS SZEGEDIENSIS

ACTA BIOLOGICA

NOVA SERIES

TOMUS XVII FASCICULI 1—4

SZEGED (HUNGARIA)

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Adiuvantibus
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redigit
ISTVÁN SZALAI

editionem curant
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Edit
Facultas Scientiarum Naturalium Universitatis Szegediensis
de Attila József nominatae

Nota
Acta Biol. Szeged

Szerkeszti
SZALAI ISTVÁN

A szerkesztőbizottság tagjai
FEHÉR O., HORVÁTH I., LIPTÁK P., MÓCZÁR L.

Szerkesztőbizottsági titkárok
BODROGKÖZY GY., HORVÁTH A.

Kiadja
A Szegedi József Attila Tudományegyetem Természettudományi Kara
(Szeged, Aradi vértanúk tere 1)

Kiadványunk rövidítése
Acta Biol. Szeged

Acta Biologica Szeged 17 (1—4), pp. 3—6 (1971)

DR. ANDOR HORVÁTH

(1913—1972)

On Tuesday morning, 8 February 1972, he set out as usual for the University: slowly, and deep in thought. Perhaps he was considering the material of his lecture. He can have had no intimation that the unusually mild, warm weather which had dispelled the winter mould bring death. His students awaited him, but on this occasion, for the first time in vain. The journay was so short, but it nevertheless led to the infinitely distant unknown, from where his arrival was unavailingly awaited by his students, his colleagues and his workplace, the Department of Zoology.

He was born in Szabadka in 1913, and came to his much-loved Szeged in 1931. He metriculated here in the same year, became a secondary school teacher of geography and biology in 1936, and in 1940 obtained his doctorate and became an honorary assistant lecturer. After 3 years as a secondary school teacher in Košice he resumed work in the Institute of Zoosystematic and Biology in our University until 1950, when he was again appointed an assistant lecturer. He soon became lecturer, and then in 1955 obtained the scientific degree of Candidate of the Biological Sciences. In 1963 he was appointed senior lecturer in the newly organized Department of Zoosystematic.

From his early yuoth he was an enthusiastic devotee of malacology, and was perfectly acquainted with the shell-fish and snails of the Szeged district. He gradually penetrated into the entire world of the *Mollusca,* and into the ecology of the recent and Pleistocene species. As a result of his exhaustive and assiduous investigations, he was able to take a single fragment of a mollusc and from this to reconstruct its proper place; and for the most part without any speciel aids he could establish the name of the species, regardless of whether this originated from some region of the Great Hungarian Plain or the mountains of Hungary, from its waters, from the depths of the Adriatic, or even from the unknown world of the layers of the Pleistocene. But he could also reconstruct that world in which these species lived, and bring its scenery and climatological and natural conditions within easy reach. His results were received with recognition by the scientific world; this was expressed when he was rewarded with membership of the Unitas Malacologica Europaea, and when he was invited to deliver lectures at international congresses in Mexico, Madrid and Warsaw.

His specialization by no means implied one-sidedness. His recognition of species, and his knowledge of ecology, systematics and zoogeography bore wit-

ness to his astonishing ability and methodicalness. In the world of the unicellular animals he was just as well informed as with any other animal group. It may be due to this that in the field of his specialization he was always able to turn to problems with assurance, and to give a completely satisfactory answer to his students and colleagues, and in a given case to the practice of agriculture.

In his research and teaching work too he avoided spectacle and all that led to easy success. This can be felt from his own words: „The pursuit of things of interest is not a task of the lecturer". In the process of teaching he clealry recognized the importance of the interdependence of the presentation and cultivation of science, and also the need for modernization. His sage attitude based on many years' experience in this field was: „We should not fall . . . . into the smallest error. We should be demanding, very demanding, but we should not wish for the impossible". In his work he a profound optimist. He professes that „an inquiring person may be formed from an indifferent one, a diligent one from a lazy one, a conscientious one from a careless one, and a person who is overall usefull from the point of view of society from a useless one. As a result of the teaching and training work the individual's faults can be kept in the background and the favourable features brought to the surface." He saw clearly that „for successful advanced teaching and training work it is necessary to have high-level qualifications, a good knowledge of people, pedagogical and psychological abilities, and developed senses of criticism and truth. But all this is not enough: devotion too is required."

He readily joined in the communal work. He took an active part in Faculty, Departmental and Interdepartmental discussions, and often pointed very properly to the tasks in the everyday life, and to useful possibilities for their solution. His command of languages, his conscientious, exact work, and his wide knowledge were used to effect in our widely respected journals, Acta Biologica Szegediensis, of which he was editor for many years. and later associatt editor, and Tiscia, of which he was a founder-member and associate editor.

He led the way in the research into the Tisza, and in the exploration of its fauna, especially its *Mollusca*. He inspired the creation of a Tisza Research Committee, which was founded under the leadership of Prof. GÁBOR KOLOSVÁRY, Corresponding Member of the Academy, the ex-Head of the Deportment of Zootaxology. He took part actively to the last as a member of the administrative staff in the work of the Committee. He fas a member of the Hungarian Biological Society and the Hungarian Hydrological Society.

His individuality was characterized by a deep humanity, a limelight-avoiding modesty, and a kind, gentle humour. Thus, not only the young but also his colleagues thought of him as „Uncle Bandi", on whose unselfish assistance they could always rely. He gave useful advice not only to the members of the Scientific Students Circle, his research and undergraduate students, but to all who turned to him in connection with their work and occupations. He at all times paid respect to serious organizational work. However, he rejected self-centredness and all that wich artificially raised a barrier to the healthy development of the individual.

He devoted himself to winning the highest scientific degree attainable with plain creative work and ablity, a Doctorate in the Biolobical Sciences. Quietly he organized and put together the last pieces of his life's work. Like so many others in the field of his profession, we waited for the fulfilment. Then, in the midst of these great plans, the early and unexpected end came with frightening suddenness. The level-headed, but in fact very sensitive being hiding behind the gentle smiles, the untiring teacher of generations, the excellent malacologist, is no more. He took his knowledge with him, but left behind 36 important publications, and a very rich colection of Mollusca including foreign material. There also remains a long line of his students to whom he passed on his knowledge of zootaxology, ecology, zoogeography and malacology, and his developed research results. He lives on in the memories of those for whom he lived, and here, between the walls of the Department, in the narrow but intimate, friendly circle who guard his memory with love and will always think of him with respect.

The task which fate assigned to him he fulfilled completely. His life had meaning. This is shown by his publications which, as evidence of his productive life, we enumerate below:

(1940): A szegedvidéki kagylók formaváltozatai és jelentőségük (Variations in the forms of shellfish in the vicinity of Szeged and their importance). Doctoral dissertation. — Szeged, 1—55.

(1943): Adatok a Tisza folyó puhatestű faunájának ismeretéhez (Data on the *Mollusca* fauna of the river Tisza). — Acta Zool. Szeged *2*, 21—32.

(1944): Beiträge zur Kenntniss der *Mollusken*-Fauna der Umgebung von Kassa. — Fragm. Faun. Hung. Budapest *7*, 39—41.

(1950): A *Physa acuta* DRAP. és a *Physa fontinalis* L. (*Physa acuta* DRAP. and *Physa fontinalis* L.). — Hidrologiai Közl. Budapest *11—12*, 449—450.

(1950): A szegedi Fehértó *Mollusca* faunája (*Mollusca* fauna of the Fehértó Lake at Szeged). — Ann. Biol. Univ. Szeged *1*, 321—326.

(1951): Muscheln aus dem Flusse Djeszna (Soviet Union). — Acta Zool. Szeged *3*, 41—47.

(1951): Adatok Putnok környékének hidrobiologiai viszonyaihoz (Data on the hydrobiological conditions in the Putnok region). — Ann. Biol. Univ. Hung. *1*, 341—350. (Co-author).

(1952): Adatok a Bánvölgy hidrobiologiai viszonyaihoz (Data on the hydrobiological conditions at Bánvölgy). — Ann. Biol. Hung. Szeged *2*, 327—344. (Co-author).

(1953): A kiskunhalasi ősláp puhatestű faunája (The *Mollusca* fauna of the palaeo-marsh at Kiskunhalas). — Hidrologiai Közl. Budapest *5—6*, 177—179.

(1954): Az alföldi lápok puhatestűiről és az Alföld változásairól (*Mollusca* of marshes on the Great Hungarian Plain and variations in the Plain). — Állattani Közl. Budapest *44*, 63—70.

(1954): Malakologiai tanulmány a Duna—Tisza-közi déli részének felső pleisztocén rétegeiről (Malacological study of the Upper Pleistocene layers in the southern area between the Danube and the Tisza). — Ann. Biol. Univ. Hung. Budapest *2*, 417—428.

(1954): A paksi pleisztocén-üledékek csigái és értékelésük (Snails in the Pleistocene deposits at Paks). (Candidate's thesis). — Állattani Közl. *44*, 171—188.

(1955): Die *Mollusken*fauna der Theiss. — Acta Biol. Szeged *1*, 174—.180.

(1956): Hidrobiológiai vizsgálatok a Szilvás patak vízgyűjtő területén (Hydrobiological studies on the catchment area of the Szilvás stream). — Állattani Közl. *45*, 13—24. (Co-author).

(1956): Über die Weichtiere des Börzsönyer Gebirges. — Acta Biol. Szeged *2*, 183—191.

(1956): Hidrobiologische und faunitische Studien in südwestlichen Teile des Bükk-Gebirges. — Acta Biol. Szeged *2*, 137—154. (Co-author).

(1956): Die Nivellierung des mitteleuropäischen Pleistocens auf Grund der *Mollusken*fauna. — Congresso Geologico International *XX*. Session Mexico, 397—400.

(1957): Über die *Mulluskenfauna* der Strecke zwischen Tiszabecs und Tiszafüred. — Acta Biol. Szeged *1—2*, 94—97.

(1957): Die Rolle der *Mollusken* in der stratigraphischen Gliederung der eolischen Ablagerungen im Ungarischen Becken. — Inqua *V*. Congresso International Madrid, Barcelona.

(1958): Die Malakologischen Ergebnisse der II. Tisza-Expedition. — Acta Biol. Szeged **4**, 216—218.
(1962): Kurzbrericht über die molluskenfauna der zwei Tisza Expeditionen im Jahre. — Opusc. Zool. Budapest *4*, 77—83.
(1962): A szegedi Múzeum recens *Mollusca* gyűjteménye (Recent *Mollusca* collection of the Szeged Museum). — Yearbook of the Móra Ferenc Museum, Szeged, 271—272.
(1962): *Mollusca*-periods in the sediments of the Hungarian pleistocene. — Acta Biol. Szeged **8**, 173—192.
(1963): Ua. II. The upper arid period of the boring of Felsőszentiván. — Acta Biol. Szeged **9**, 101—115.
(1963): Adriatic mollusca of the Split area. — Acta Adriatica Split *10*, 1—12
(1963): A Móra Ferenc Múzeum fekete-tengeri *Mollusca* gyűjteménye (The Black Sea *Mollusca* collection of the Móra Ferenc Museum) (Die *Mollusken*-Sammlung Schwarzmeergebiet in dem Szeged Móra Ferenc Muzeum). — Yearbook of the Móra Ferenc Museum. Szeged, 233—236.
(1964): The upper humid period of the boring of Felsőszentiván. — Acta Biol. Szeged **10**, 131—146.
(1965): The upper part of the middle arid period in the boring of Felsőszentiván. — Acta Biol. Szeged *11*, 153—164.
(1966): About the mollusca of Tisza before the river control. — Tiscia (Szeged) *2*, 99—102.
(1966): The middle part of the middle arid period in the boring of Felsőszentiván. — Acta Biol. Szeged *12*, 149—158.
(1967): Data about the *Mollusca* of Adria. — Acta Biol. Szeged *13*, 137—141. (Co-author with K. BÁBA.)
(1967): The fossil Holocene *Mollusca* fauna of the lake at Kardoskút and environs. — Acta Biol. Szeged *13*, 133—136.
(1968): Prof. Dr. GABRIEL KOLOSVÁRY. — Acta Biol. Szeged, Tom. *14*, 1—4.
(1969): Prof. Dr. GÁBRIEL KOLOSVÁRY. — Tiscia (Szeged) *5*, 3—13.
(1970): In memoriam ADOLF LENDL. — Acta Biol. Szeged *16*, 17—19.
(1971): A biológiai tárgyak a felsőoktatásban (Biological subjekts in higher education). — Felsőoktatási Szemle *20*, 458—463.
(1971): *Mollusca* periods in the sediments of the Hungarian pleistocene. VI. The lower part of the middle arid period in the boring of Felsőszentiván. — Acta Biol. Szeged (in print).
(1972): A Tisza árterének és holtágainak vízi *Mollusca* faunája. — Tiscia (Szeged) **7**, (in print).

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Acta Biologica Szeged 17 (1—4), pp. 7—16 (1971)

HISTORY OF BOTANY IN THE ATTILA JÓZSEF UNIVERSITY (1921—1970)

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(Received April 20, 1971)

A. History of The Institutes for Botany

May 29 1921 is a significant date in the cultural life of Szeged. That was the day when Hungarian Parliament voted the bill assigning the town of Szeged as headquarters of the Ferenc József University displaced from Kolozsvár. This event caused headline reports in the local press, including interviews with leaders of the municipal administration and with representatives of the new establishment. The opionions on the present and future of the university were sometimes extremist, in fact contradictory, but local press played certainly an important role in calling the attention to the new university and its problems both in the country and abroad.

Phase 1

After working for a while in Budapest, Professor ISTVÁN GYÖRFFY came from Kolozsvár to Szeged to be Head of the Institute for Botany: his aim was to develop the respectable traditions of his predecessors (VINCE BORBÁS, ALADÁR RICHTER) in the Institute for Botany of Kolozsvár University and to introduce the love of science in Szeged, too.

In the very first years of his activity he wrote number of informative articles, almost regularly published reports, for keeping Szeged public opinion well informed, in return for the „great sacrifices" made by the citizens for the university. Professor ISTVÁN GYŐRFFY was the founder of the Institute for General Botany and headed it from 1921 to 1940.

The Institute for Botany was working in 1921 on the first storey of the State Grammar School the present Radnóti Grammar School, where some 14 premises were equipped to the purposes of instruction and research work (350 sq. m.). After ten years (1931), when the clinical buildings of the Medical Faculty were already standing, the institutes of the Faculty for Natural Sciences could also obtain their final quarters. In the large buiilding of the former Railway Accounting Office (to-day: Táncsics Mihály Street 2) the Institute for General Botany, together with other institutes of natural sciences (zoology, geology, mineralogy), obtained its definitive home.

The Institute occupied in the new building on the 1st storey a surface of 1190. sq. m. including 22 rooms, a well equipped botanical museum and herbarium, assuring fair possibilites for progress.

The teaching and research staff included the Professor, a junior lecturer, two assistants and a research student.

Professor GYŐRFFY refers to the first years as to the „heoric period" of the Institute. „All furniture of my study consists of a kitchen table and a case," he writes in his recollections. Generous gifts were characteristic of that period, when the Institute had to be establisched practically from nil. As the very basis for any further scientific work, major gifts of books were sent by the Hungarian Geographical Society and the Institute for General Botany of Péter Pázmány University in Budapest. Other valuable school equipment included the gifts of the Herbarium of the Hungarian National Museum and of Tartu University (Finland), as well as the significant collections of GAYER, WAGNER and HULJÁK and other precious contributions from renowned scientists and private collectors for the botanical museum.

As a result of clever organizational work, the Institute was substantially supported by the Rockefeller Foundation and the Széchenyi Research Foundation. These funds permitted the Institute to start its own periodical „Folia Cryptogammica" in 1924 which regularly published papers received from foreign scientists, too (edited by „Mars" Press, Szeged). Prior to that date, the members of the Institute staff published their papers either abroad or in „Acta" (edited by the Association of the Friends of the University), which can be regarded, as a matter of fact, as the first publication of Szeged University.

In compliance with time-spirit, the educational work of the Institute was charanterized by the autonomy of the university: so, for instance, there were never any lectures on taxonomy and phytogeography, although the formation of teachers would have required lectures on the whole domain of botany. Instruction was concentrated on the lectures and practical studies on morphology and physiology. A complete and up-to-date equipment made for successful instruction. According to the division of botany, there were special histological laboratories for floriferous and cryptogamous plants, as well as physiological premises and working rooms for the candidates for doctorate. Micro- and macro-photo-laboratories were answering to superior prefossional expectations. The formation of teachers played only a secondary role in instruction.

The research work of the Institute was mainly concentrated on the overall examination of the cryptogamous plants to be found in the Great Hungarian Lowland and the High Tatra. This was actually the pursuance of the research trend within the Institute for Botany of Kolozsvár and was highly successful indeed as shown, among others, by the list of distinguished scientists who have started their scientific career in Szeged (Professor TIBOR HORTOBÁGYI, Professor ISTVÁN KISS, the research-workers ERZSÉBET KOL, GÁBOR SZEMES, LÁSZLÓ GALLÉ, GÁBOR UHERKOVICH). However, this „school" ceased to exist in 1940 when the University returned to Kolozsvár.

The adherence to Kolozsvár traditions was expressed also by Professor GYŐRFFY's consistent ambition of creating the Botanical Garden. Received from the city of Szeged, an area of 10 hectares (in Királica) was symbolocally occupied already in November 1922, but some years were still needed to achieve any progress. The still existing lake was established at that time, and *Nelumbo* was successfully introduced. The hill made of the excavated earth

was planted with alpine flora, the required material being usually gathered by members of the Institute in the High Tatra.

The Botanical Garden was representative of the flora of Hungarian regions, including the vegetation of the sandy lowlands as well as the forests and typical plants of the river-banks. With its rich stock of conifers (spruce, black pine, Scotch fir) the sector „Fenyőháza" represented the vegetation of high mountains. With a highly developed artistic sense, Professor GYŐRFFY shaped the caracteristic regional units of the Hungarian Lowland, the typical sweep-well, as well as the vegetation of the salt lakes with specially settled storks and other water fowl.

Prof. GYŐRRFY used the Botanical Garden also as means for bringing the students nearer to nature. Resting benches were arranged along the main roads of the garden in suitable environment with the purpose that the students should learn and work there in fine weather. With the same purpose he arranged walks every second Sunday (Botanical Garden, Kállai grove, Dorozsma, surroundings of Lake Fehértó), with possibilities for both botanical and zoological observations.

The Botanical museum was a remarkable establishment of the Institute occupying a rather big area (ca. 100 sq. m.). The exhibits included original collections of renowned scientists, various teratological phenomena, crops as well as objects collected by LAJOS BÍRÓ in New Guinea. As part of the museum let us mention the Alaska collection which the junior lecturer of the Institute, ERZSÉBET KOL, brought from her North American study tour. On payment of a modest entrance fee the museum could be visited by the public on the first Sundays of every month. Documentary films on the museum, the Alaska collection and the life of the Institute are kept at present in the Institute for Botany.

The reutrn of the Ferenc József University to Kolozsvár marked the end of the first and the beginning of the second phase in the development of botanical activity in Szeged. As a result of Prof. GYŐRFFY's activity, the first 19 years may be characterized by the establishment of the Institute, the scientific organizational work and as a concequence of these the rousing of international reaction. Although the Head of the Institute was not immune from the fashionable disease of those times, i. e. excessive nationalism and irredentism, this fact does by no means diminish the importance of his activity accomplished in the interest of botany.

Phase 2

In October 1940, Professor PÁL GREGUSS was appointed Head of the Institute for Botany. He introduced a new research trend, divergent from traditions, concentrated on Xylotomy and paleobotany. The examination of cryptogamous plants and taxonomic research work were fell into the Background. The organization of the new Institute was started with help of a few, but enthusiastic young botanists (ISTVÁN SZALAI, ISTVÁN VARGA, ERNŐ VAJDA, EMMA PÁHÁNY and, for a short while, ISTVÁN NAGY and MARGIT SZABADOS from the Institute headed by Prof. GYŐRFFY). As contrasted with former traditions, Prof. GREGUSS did not regard as the University's main task the training of scientists but rather the education of professionally highly qualified pedagogues who would be able to propagate botanical knowledge.

The work of the new Institute was sensibly impeded by the outbreak of the Second World War. Hardly did the educational and research work begin, when a number of staff members were called up for military service and the air-raids began. On account of successive superior orders (concerning civil defence and evacuation) the whole activity of the Institute became formal.

War did not spare University either. In 1945, the University building in Baross Street was temporarily used as a hospital. The library, the herbarium and part of the instruments (what remained of them after the war) were transferred into the building in Cathedral Square (Dóm tér): the furniture of the Institute was however almost fully destroyed. Only a small part of the instruments transferred by Government orders to Sopron was returned to the Institute.

The educational staff of the Institute was partly exchanged after the war. ISTVÁN NAGY, ISTVÁN VARGA, ERNŐ VAJDA and EMMA PÁHÁNY were replaced by GYÖRGY BODROGKÖZY, MÁTYÁS PÁLMAI and MAGDOLNA VARGA.

Socialist reorganization of the University began after Liberation with the admission of young workers and peasants, and continued with the gradual repression of bourgeois traits in university life with the development of a democratic way of life.

While the equipment was rather poor both in quality and quantity, the number of students increased every year (max. 140). The tasks of the Institute included not only the training of teachers but also the botanical instruction of pharmacy students. A major problem was the lack of manuals and lecture notes, being, anyway, lightened by the distribution of lecture notes (written by ISTVÁN SZALAI, with the cooperation of MAGDOLNA VARGA); the eight lecture notes treated the subject-matter separately for the future teachers and the pharmacy students.

Xylotomy, which was actually the backbone of research work, was developed both in Hungary and on international level mainly by Prof. GREGUSS and, under his guidance, by the working staff of the Institute for Botany (I. SZALAI, I. VARGA, M. PÁLMAI, I. HORVÁTH), after the early death of FERENC HOLLENDONNER. The results achieved in antracotomy, microtechnique and histochemistry (I. SZALAI) were closely attached to this field of research.

Some thirty scientific publications written by the staff members of the Institute appeared in Acta Bot. Univ. Szegediensis and other periodicals (Borbásia, Földtani Közlemények, etc.). A monograph by Prof. GREGUSS, „The Identification of Central-European Dicotyledonous Trees and Shrubs Based on Xylotomy", which started a series of xylotomic monographs, was also published at that time.

After 1945 the Institute accomplished a substantial work in propagating popular science and raising the cultural standard of the masses. The young staff members held lectures in villages and towns and contributed largely to the success of the secondary study courses (preparation for the final examination of the secondary school), organized for workers who previously had no chance of studying (I. SZALAI, MAGDOLNA VARGA, GY. BODROGKÖZY).

Right from the beginning (1940), Prof. GREGUSS introduced the dendrological trend in the development of the Botanical Garden; many trees and shrubs were brought from the Szarvas arboretum founded by Count BOLZA (the

so called „Pepi Garden"). When the „Pepi Garden" was declared a nature conservation area (Nov. 4, 1943), the proprietor, Count BOLZA, did his best to remit the arboretum to the management of the Institute for Botany. Unfortunately he failed as did also the Institute in its efforts to obtain a new and more suitable area for the Botanical Garden after the catastrophic devastations caused by groundwater in 1940—1942.

By the end the fourties (1948), the scheme of another institute (No. II) for botany was outlined, for the primary reason that the educational staff was too small to fulfil the increased scope of duties. In 1948 Prof. GREGUSS suggested the idea of establishing a new institute for botany and of augmenting the area of the Botanical Garden from 10 to 15 hectares. On the sports ground next to the University building a botanical garden was suggested to be established for demonstration purposes — but none of the plans as realized.

The year 1952 is an important mile-stone in the history of botany in Szeged University. The Institute for Botany was divided and a new Institute established. Headed by senior lecturer ISTVÁN SZALAI, the new Institute for Plant Physiology was detached from the mother institute which was named henceforward Institute for Plant Taxonomy and Morphology. So the new Institute was not started according to former conceptions on the taxonomic line, but was specialized — in compliance with the growing importance of physiological research work — on plant physiology and microbiology and thus independent research work could be started within the Faculty of Natural Sciences on these two disciplines, too.

With the detachment of plant physiology, the Institute for Plant Taxonomy and Morphology obtained new possibilities of development. Scientific activity could be differentiated and extended on domains which, so far, had not been investigated in Szeged.

After the departure of the physiologists (I. SZALAI, M. VARGA, É. SIBALIN, K. KISS) the ranks of the Institute were filled with young educational and scientific forces. Xylotomic examinations were continued on conifers, together with successive paleo-xylotomic publications (P. GREGUSS) and, as a result of the activity of GYÖRGY BODROGKÖZY, with works on plant geography and coenology (1955). Cytological (I. MARÓTI) and histological (S. GULYÁS) examinations were started. The application of electronmicroscopic technique was introduced by the works of SZERÉN PATAKI. Especially in the early sixties, the main field of palynological research work, i. e. paleopalynology, made considerable advances. In cronological respect the palynological research work was concentrated on the miocene (P. SIMONCSICS), the eocene (M. KEDVES) and the lower cretaceous period (M. JUHÁSZ). In this domain important international contacts were established and intensified by a sudden increase in the number of publications; this in turn, expressed the intensification of research work.

In connection with the development of the Botanical Garden, the greenhouses were modernized. The first ironstaged hothouse was built in 1953 and was followed in 1958 by two others. The Botanical Garden was subdrained for better protection against the high groundwater level (1965).

In 25 years, the professorship of PÁL GREGUSS and particularly the xylotomic and palynologic works earned for the Institute a world-wide reputation; extensive international contacts were established and are still maintained. The comprehensive activity of Prof. GREGUSS resulted in a significant synthesis of

xylotomy which keeps Hungarian research work on level with international standards.

When Prof. GREGUSS retired in 1965, the Institute and the Botanical Garden were temporarilay committed to Professor ISTVÁN SZALAI, Head of the Institute for Plant Physiology, until senior lecturer IMRE HORVÁTH was appointed the new Head of the Institute (Sept. 1, 1965).

Phase 3

The development program of Prof. HORVÁTH was aimed primarily at the introduction of research work on a field of science expressing the demands of the age: production biology. At the same time, the training of biologists was started to be modernized; the Institute played a major role in that large-scale work.

After the subjective and objective fundamentals had been ascertained, the available instruments, laboratory equipments, etc. were completed and modernized.

Lasting two years, this „installation" created the conditions for the modernization of educational work and, by establishing an up-to-date degree of instrumentation, laid the material foundations for the accomplishment of new research tasks. The substantial help of the University and of the Hungarian Academy of Sciences permitted jointly to achieve these objectives in a comparatively short time.

The five years from 1965 to 1970 brought important changes in the life of the Botanical Garden as well. The garden area was increased from 10 to 15 hectares, but unfortunately the manpower remained unchanged.

By 1970 a phytotron was built in the Botanical Garden, with a total investment of 2,5 million Forints. Up-to-date dressing and bathing accomodations and eating-rooms were built additionally.

Asphalted roads were made in 2 km length, modern illuminators were installed. Due to the renovation of the rosary and the cleaning of the paths, the Botanical Garden makes the impression of a cultivated and wellkept garden. Training in plant morphology, taxonomy and ecology is given to the teacher-trainees in biology and biology-chemistry as well as to pharmacy students according to the requirements of the respective specialities. As shown by the growing number of special workers and members of students' associations, the students are highly interested in the lectures of the Institute. In compliance with the requirements of the up-to-date training of biologists, the Institute organizes special courses on subject-matters that are not included in its own research program, but are of actual interest for the students; frequently even specialists of the Hungarian Academy of Sciences are invited as lecturers (A. GARAY, P. TÉTÉNYL, I. PRÉCSÉNYI). In co-operation with the Institute for Zootaxonomy, the Institute takes its students every year for botanical and zoological field work in the Soviet Union, in the regions of Odessa, the Caucasus and the Black Sea.

In the last five years the life of the Institute underwent some changes not only in so far as a new research trend (production biology) joined the scientific domains investigated so far but also on account of the development of science organization combined with adequate participation in public life. As the Hun-

garian representative of the Photosynthesis Committee of the COMECON, Prof. I. HORVÁTH has established active international scientific contacts. As a result thereof, the Institute was able to receive for a rather long time six specialists from abroad (1 Czecho-Slovak, 1 Indian, 2 Arabians, 1 Soviet, 1 Vietnamese); the Indian specialist is actually working at the Institute for a higher scientific degree.

The members of the educational staff have undertaken study tours ranging from 1 month to 1 year.

The members of the Institute staff are publishing their papers mainly in Hungarian periodicals, first of all in Acta Biol. Szegediensis and in other Academic journals (Acta Bot. Hung., Acta Biol. Hung., Acta Bioch. et Biophys. Hung., Bot. Közl., etc.) as well as in foreign reviews.

Educational lectures were held in radio and television, and some articles were published on popular scientific matters.

B. History of the Institute for Plant Physiology

For want of adequate equipment and instruments, the Institute for Botany had but modest possibilities for educational and research work in plant physiology and microbiology.

The large-scale development of university education and the growing requirements of modern agriculture in the fifties of this century emphasized the necessity of developing and dividing the Institute since, within the narrow range of its actual possibilities, it was unable to comply perfectly with the scope of its manifold duties (training of teacher-trainees in biology and pharmacy students).

In March 1952, a degree of the Ministry of Public Education established the Institute for Plant Physiology which began to work in September 1952 under the leadership of ISTVÁN SZALAI, so far senior lecturer at the Institute for Botany.

The new Institute for Plant Physiology was accomodated in some of the premises of the Institute for Plant Morphology and Taxonomy.

It started working under rather modest conditions — with borrowed furniture, a minimum degree of instrumentation and a small staff. The educational tasks were performed by the Head of the Institute, the assistants MAGDOLNA VARGA and KLÁRA KISS and the research student LAJOS FERENCZY. In addition, the staff included a research worker, an administrator and an office attendant (Cf. I. SZALAI, Acta Biol. Szegediensis suppl. 1962. Tom. VIII).

The first task was to establish proper conditions for educational and research work. Material support permitted gradually the purchase of furniture and of the main instruments required for basic research and education. With growing requirements and the increase of the working-staff, however, the lack of adequate premises and hothouses became more and more detrimental. As a minimum, a small hothouse was built in 1961 in the widened hanging gallery on the 1st storey, but the disadvantageous light conditions and the lack of air-conditioning, in fact, of proper heating, made it difficult to rear the plants indispensable for the practices and research.

The working-staff of the Institute was augmented in the years 1957—1962. Together with the Microbiological Study Group established in 1969, any further development of the Institute seems to be impossible on the given area. As a matter of fact, the 30 members of the Institute staff are working under out-of-date conditions indeed.

The curriculum of the Institute includes plant physiology, plant cultivation and microbiology. In both the preparation and the realization of the educational reform in biology, the Institute accomplished a significant work in the formal and substantial reformation of the instruction in plant physiology and microbiology. The students are keenly interested in these two important and highly practical disciplines, as shown by the number of students' association members (yearly 4—8) and of the authors of special dissertations.

From the very beginning up to the present day the research work of the Institute is concentrated on the examinations in genetic physiology, particularly on the mechanism of action of hormones and hormone-like compounds regulating growth and the state of rest. Internationally recognized results were achieved in this work (I. SZALAI, M. VARGA, E. KÖVES, M. NAGY). The physiological tests on potato should be specially mentioned, performed on an operating scale by the Institute staff in 1952—1956 on behalf of, and sponsored by, the National Patents Office, where by the problem of potato cultivation and the obtention of high-quality sowing-tubers was successfully resolved. Since the Physiological Research Group of the Hungarian Academy of Sciences was transferred from Vácrátót to the Institute (1957), the research field was extended to the physiology of yeasts (J. ZSOLT), the uptake of mineral elements (F. ZSOLDOS) and the amino-acids (G. PÁLFI).

The double line of the Institute reveals itself more and more distinctly in research work. In addition to the investigations in plant physiology, a most intensive, collective research work is being accomplished by the Microbiological Study Group (L. FERENCZY, J. ZSOLT, R. VÁMOS, F. KEVEI). Besides physiological investigations on fungi, there is also an important research work done on pharmaceutical basic materials and compounds with antibacterial and antifungal effect as well as on their mechanism of action.

The members of the Institute staff have undertaken study tours ranging from 3 months to 1 year, and delivered regularly lectures abroad.

The fact that the scientific results of the staff members are referred to with growing frequency in foreign publications, shows also the development of the Institute. The primary condition there of is the publication of numerous papers abroad, as well as the fact, that, in compliance with their scientific standing, the Hungarian periodicals are being more and more widely read.

The Institute plays an outstanding role in text-book literature in Hungary. The activity of Prof. ISTVÁN SZALAI should be specially mentioned here as that of the author of the following university texts-books „Practical Exercises in Plant Physiology I." (in co-operation with Professor SÁNDOR SÁRKÁNY), „Experiments in Plant Physiology" (in co-operation with Prof. VILMOS FRENYÓ), (1962), „Biology and Progress" (1968) and „Plant Physiology" (1968). Lecture notes were written on microbiology by J. ZSOLT—R. VÁMOS in 1963 and by L. FERENCZY—J. ZSOLT 1969, and published in 1970.

The members of the Institute staff are most active in the popularization of science, too. In 1970 they have organized a lecture series for radio broadcast and are regularly co-operating with the Society for the Propagation of Science (TIT); finally, they are writing a number of popular-scientific articles in various periodicals.

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A retrospection on the fifty years of botany in Szeged University fills us with satisfaction at the sight of the significant progress achieved in spite of smaller or greater difficulties.

The number of the botanical institutes has grown from 1 to 2, and that of the staff members from 5 to 47, including 3 professors, 5 senior lecturers, 6 junior Lecturers, 1 assistant, 4 research workers and 28 auxiliary employees.

In Szeged 14 students have taken their doctor's degree in botany during the professorship of ISTVÁN GYŐRFFY, and 39 others from 1945 to the present day. If we compare the situation prevailing before and after Liberation, the number of doctorates, proportional to the growing number of graduated students reveals the trend of development in this field.

Three members of the eductional staff of the three Institutes have obtained the scientific degree „Doctor of Biological Sciences", while 8 other members are „Candidates of Biological Sciences".

Some members of the Institute staff have received high state and scientific distinctions: Professor emeritus Dr. PÁL GREGUSS was awarded the Order of Labour in gold in the year of 1955, 1959 and 1965 and the silver degree of Kossuth Prize in the year of 1958 while Professor Dr. IMRE HORVÁTH and senior lecturer Dr. ELIZABETH KÖVES have been cenferred the title „Honoured Worker of Public Education".

As a continuation of Folia Cryptogammica — the periodical founded by Prof. GYŐRFFY — Acta Biologica Szegediensis (Nova Series) has published since 1955, on a wider and more general line, a total of 333 articles and constitutes the very basis of the important library exchange of the two Institutes (210 exchange partners).

In 50 years some 900 scientific publications have been edited in Szeged on botanical and phytophysiological subjects. (bot. bibliography, MSS) 450—500 papers resulted in 50 years from botanical research work, while plant physiology was treated during the last 18 years in nearly 400 papers. In the 20 years before the war the Institute for Botany has published only one text-book, while a dozen of scientific monographs and text-books, were published by the staff members of the two Institutes since 1945. To sum up what has been said: — There were five principal research trends developing during the fifty years of botanical activity in Szeged, representing at the same time the successive stages of development of botany in this town:

I. Research of cryptogamic plants (1921—1940) by Prof. Dr. I. GYŐRFFY.
II. Development of the xylotomic paleo-botanic and palynologic trend since 1940), atteched to the name of Prof. Dr. P. GREGUSS.
III. Start of research work on plant physiology under Prof. Dr. I. SZALAI (1952). The main subject was the research on growth-regulating substances, but other fields of metabolic research work and isotope technique are also involved.

IV. With the appointment of Prof. Dr. I. HORVÁTH the plant ecological production tests were started in 1965.

V. In recent years microbiological research work is also playing a major role, leading to the establishment of a new Study Group headed by senior lecturer Dr. L. FERENCZY.

The introduction of new research themes indicates not only a general expansion of the spheres of interest, but reveals also an overall characteristic of the development of biology, i. e. the research work becoming more and more profound and exact with intensive application of instrumental methods. List of text-books published in 50 years during the activity of the authors in Szeged:

1. GREGUSS, P.: Bestimmung der mitteleurpäischen Laubhölzer und Sträucher auf xylotomischer Grundlage. Mit 1000 Orig. Mikrophotographien und 250 Tafeln mit Originalzeichnungen. Sopron 1947. The Identification of Central-European Dicotyledonous Trees and Shrubs based on Xylotomy, with 1000 microphotos and 250 plates of original drawings. Sopron 1947.
2. GREGUSS, P.: (Botanisches Institut der Univ., Kollaborator I. Varga): Xylotomischer Bestimmungsschlüssel der Pinus-Arten. Pp. 1—138, fig. 68, 95 photos. Szeged 1950.
3. GREGUSS, P.: Xylotomische Bestimmung der heute lebenden *Gymnospermen*. Mit 1500 Orig.-Mikrophot. und Zeichnungen auf 360 Tafeln, 8 Tab. Budapest 1955.
4. GREGUSS, P.: Identification of living *Gymnosperms*. With 1500 orig. photos and drawings on 360 pl. Budapest 1955.
5. GREGUSS, P.: Holzananatomie der europäischen Laubhölzer und Sträucher. Mit 1257 Orig.-Mikrophot. und Originalzeichnungen auf 307 Taf. 6 Tab. pp. 1—330. Budapest 1959.
6. **Грегуш П.: Определитель древесины голосеменных по микроскопическим признакам (Пер. В. Р. Филина и О. Н. Чистяковой.) Рис. I—86. стр. I—157. Москва 1959.**
7. GREGUSS, P.: Fossil-*Gymnosperm*-Woods in Hungary from the Permian to the Pliocene. 136 Pages, 14 maps, 670 orig. microphot. on 87 tabl. Budapest 1967.
8. GREGUSS, P.: Xylotomy of the living Cydads with a description of the leaves and epidermis. 950 microphot. and drawings on 185 plates, 80 fig. Budapest 1968.
9. GREGUSS, P.: Tertiary *Angiosperm*-Woods in Hungary. Pp. 1—151, 90 tabl., 750 photos, Budapest 1968.
10. GREGUSS, P.: Einführung in die Paläoxylotomie; Untersuchungsmethoden der fossilen Hölzer. 18 Tafeln mit 230 Photos. Geologie, Berlin 1968.
11. KEDVES, M.: Palynological Studies on Hungarian Early Tertiary Deposits. 84 pp. 22 plates, Akadémiai Kiadó, Budapest 1969.
12. KOL ERZSÉBET: Tiszaparttól Alaszkáig. (From the Tisza to Alaska). K. M. Természettudományi Társulat, Budapest 1940.
13. SZALAI, I.—SÁRKÁNY, S.: Növénytani praktikum I. (Practical Exercises in Plant Physiology). Practices in Plant Morphology. 3rd revised edition. Tankönyvkiadó, Budapest 1964.
14. SZALAI, I.—FRENYÓ, V.: Practical Exercises in Plant Physiology II. Experiments in Plant Physiology. Tankönyvkiadó, Budapest 1962.
15. SZALAI, I.: A biológia és a haladás (Biology and Progress). Tankönyvkiadó, Budapest 1967.
16. SZALAI, I.: Növényélettan (Plant Physiology). Tankönyvkiadó, Budapest 1968.

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Acta Biologica Szeged 17 (1—4), pp. 17—28 (1971)

HISTORY OF THE ZOOLOGICAL DEPARTMENT IN THE UNIVERSITY OF SZEGED

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(Received July 21, 1971)

The Department was founded in 1872 at Kolozsvár, in the Faculty of Natural Sciences of the Francis Joseph University. Its first heads were GÉZA ENTZ, Sr., JENŐ DADAI and ISTVÁN APÁTHY. Under the peace treaty of Trianon Transylvania, including Kolozsvár with the seat of the University, were annexed to Romania in 1920. This involved the consequence that the Francis Joseph University and the University Zoological Department of Kolozsvár were liquidated. A part of the departmental equipment was taken to Budapest by BÉLA FARKAS, then junior lecturer in the Department, and accommodated temporarily in a primary school-building. In 1921 the professors of the University repatriated to Budapest moved with the equipment brought from Kolozsvár to Szeged where the University, using its old name, resumed work with four faculties. As one department of the Faculty of Natural Sciences, the Zoological Department was accomodated in the Gábor Baross Grammar School. (in Baross Gábor str. 2). Also ISTVÁN APÁTHY arrived to Szeged in 1922 and started his lectures in the poorly equipped Department. ISTVÁN APÁTHY was born in Budapest on January 4, 1863. After completing his secondary studies, he immatriculated at the Medical Faculty of Budapest University. After his basic studies, he worked in the Institute of Pathological Anatomy where he was engaged in comparative zoohistological studies. He graduated as a Doctor of Medicine in 1885, and following his inclination for zoology, was appointed to assistant to TIVADAR MARGÓ, then professor of general zoology and comparative anatomy. After one year's work as the professor's assistant he was transferred to the zoological station of Naples in 1886 where he worked at the Hungarian desk with shorter and longer interruptions for three years. In 1890, at the age of 27 years, he was appointed to professor at the Zoological Department of the University of Kolozsvár. The Department, accommodated at that time in the villa of a count MIKÓ, was extremely small and the equipment was rather scanty. Despite this circumstance, people came there in masses from all corners of the globe to acquire APÁTHY's microtechnique ascended to world fame by then. Based on the conceptions and instructions of ISTVÁN APÁTHY, the immense Zoological Institute of the Kolozsvár University was completed in 1909 being virtually unparallelled all over Europe at that time. The high quality of instructional, educational and scientific work in the new institute under the leadership of ISTVÁN APÁTHY won world wide renown both to the leader of the institute and the institute

itself. But all this could not be continued in the new institute in Szeged. ISTVÁN APÁTHY was seriously ill at that time. His progressive cardiopathy disabled him more and more and he died after long suffering on September 27, 1922. With him a muchsuffered man, a great genius and a far-lighting torch vanished from the scene of Hungarian scientific life — but his spirit has survived among us, and all over the world where there are love and enthusiasm for science, where people can work and, if needed fight for science.

If we wish to appraise in merit the work of ISTVÁN APÁTHY done during his career outlined in the foregoing, we must survey three fields in which he was really great having produced lasting values and achievements for science. The first one is zoology, the second neurohistology, and the third one micro-technique.

ISTVÁN APÁTHY's zoological studies started in Budapest and were continued in Naples at the Stazione Zoologica. These studies concerned the taxonomy and anatomy of leeches. For these studies APÁTHY collected the material in the gulf of Naples and in waters of Hungary. He conserved a part of that material in usual ways, but the most part of them were fixed embedded and processed histologically.

He carried out his neurohistological investigations with the gilding method — named after him — in the intestinal tube of the sea leach *Pontobdella muricata*. In the course of this work he was the first in world literature to stain the intestinal nervous system of this leech with almost miraculous clearness. In these preparations, of which the most beautiful ones are in my possession, the nervous system of the intestine and the pattern of its connection with the intestinal wall appear with extraordinarily fine definition and clearness. In my opinion this fact in itself sufficed to keep the name of ISTVÁN APÁTHY for posterity, to gain positive international appreciation for his work and to distinguish him with objective esteem. But this is not all, or not the only thing, that ISTVÁN APÁTHY found out and laid down in a lasting form in connection with these studies. It was he, who succeeded in proving, and making acceptable at his time, that fine fibrils (neurofibrils) are running in the protoplasm parallel or arranged in a network-like manner, in the nerve cells, the sensory cells, and in their processes. APÁTHY regarded these fibrils as the leading elements of the nervous system; he went even much farther in the morphological and physiological evaluation of the neurofibrils professing that they pass through the cells, the centres, even the muscle fibres, forming thereby a coherent system which pervades the entire organism and integrates the nervous system with all its elements into a continuous unity. With the „continuity" theorem APÁTHY declared war on the neuron theorem, on synaptology, in short, on the theorem of stimulus transmission of „contiguity", and became the initiator of heated controversies which for a long time went on with extreme vehemence mainly between him and so distinguished representatives of the neuron theorem RAMÓN Y CAJAL, MIHÁLY LENHOSSÉK, and others. This brief appraisal does not permit us to embark on a discussion in merit and analysis of this question being even we ourselves neuronists; so much must anyway be said that, in our opinion, APÁTHY went beyond the limits and possibilities permitted by his preparations. In our view — and this is also proved by the preparations in our possession which were made from the intestinal tube of the *Pontobdella muricata* by APÁTHY in Naples in

1882 — he failed to take into account certain facts and features when he reported on cells in the intestinal wall through which the neurofibrils passed without interruption and extended continuously in the organism. The reason was that he had gilt the intestine in its totality and that gave rise to the pictures described in his work „Das leitende Element des Nervensystems und seine topographischen Beziehungen zu den Zellen." Otherwise the battle which broke out with the publication of this work has been decided by now, and to the advantage of the neuron theorem. The pictures of nervous system obtained with recent methods and with the electron microscope and the changes appearing as a result of experimental interventions, speak for being is no continuity, and the neuron theorem has full validity both from the anatomical and physiological point of view. As one who has studied for more than 40 years the histological structure of the nervous system of practically all classes of the animal kingdom, I have always held that there is neither plasmic, nor dendritic, nor neurofibrillar continuity in the nervous system. Any picture of nerves which so far has seen the printer's ink in this respect is based on a mistake or it is a result of inadequate technique. As concerns the neurofibrils I am of the opinion that these do exist, but are not apparent in every case, and never leave the area of nerve cells. They are simply components of the neuron like the tigroid, the cytocentrum, the GOLGI complex and all the others. Yet despite all this, as one who works in a similar field and is the second successor of ISTVÁN APÁTHY in the Department, I profess and declare that he as a neurohistologist carried out a pioneering and outstanding work.

The third field in which APÁTHY was really great is the microtechnique. Many people were active in this field before him, making available to researchers many a useful method and procedure, but we must say with due impartiality that there was no one among the histologists and cytologists who would have surpassed ISTVÁN APÁTHY in meticulous care, accuracy, inventivennes, ingenuity and skill. Experience and results originating from APÁTHY's work are generally known and many of them are still widely used. I refer here to the double embedding, triple staining, gilding and other procedures. All this shows quite clearly that ISTVÁN APÁTHY was a brilliant thinker, a personality of great stature experimenting speculatively and investigating ponderingly, making efforts to organize and create instruments and methods with whose aid he could find answers to his questions from the world of living nature. But as a microtechnicist he became really great, known and appreciated all over the world, when he put in chronological order the empirical results and experimental facts established by others and by him, summing them up, analyzing them critically and thus elevated microtechnique to the rank of a discipline. The result of this activity were his 2 volumes on microtechnique, „Die Mikrotechnik der tierischen Morphologie" (Abt. I, 1896; Abt. II. 1901).

ISTVÁN APÁTHY was not only an outstanding researcher and good organizer, but proved to be also an exemplary master in the education of a new generation. From among his pupils JÓZSEF GELEI, BÉLA FARKAS, JENŐ MÁTYÁS and GÁBOR KOLOSVÁRY worked in the University of Szeged, MIHÁLY ROTARIDESZ, the outstanding expert of the Molluscs, was active in the zoological gallery of the Hungarian National Museum, and LAJOS BOGA, professor of zoology in Bolyai University, remained in Kolozsvár.

ISTVÁN APÁTHY's successor in the Zoological Department was his first assistant and privat-docent JÓZSEF GELEI, who, after and interval of one year, came to Szeged and at the institute of Baross street started with great diligence on building up the institute that was a rather difficult work and came up against many obstacles. One considerable achievement of his work, holding out far-reaching prospects, was that the Zoological Department of the University of Szeged was the first in Hungary to be divided into two sections to which two professors were appointed as leaders. One was named „Institute of General Zoology and Comparative Anatomy", the other „Institute of Zoological Taxonomy". Both institutes started working at the place of the old Zoological Institute, resp. as its continuation. JÓZSEF GELEI was appointed to professor of the first in 1924, and BÉLA FARKAS, ISTVÁN APÁTHY's other junior lecturer was appointed to professor of the second, also in 1924.

JÓZSEF GELEI was born at Árkos, on August 20, 1886. After completing secondary studies he immatriculated at the Faculty of Natural Sciences in the University of Kolozsvár where he acquired qualification as a teacher of biological subjects. After completing his university studies he was appointed ISTVÁN APÁTHY's assistant, later junior lecturer and then privat-docent. He started his scientific research work with the study of the microscopical anatomy of worms. From the beginning his favourite was the mil-white flatworm (*Dendrocoelum lacteum* OERSTED). He wrote an extensive monograph on its histology, entitled „Studies of the Histology of *Dendrocoelum lacteum* OERSTED". Based on his extensive investigations, he described in that work the histological structure of this animal, accompanied by numerous most exquisite drawings occasionally making thorough excursions into cytology which remained GELEI's, favourite field of research also later on. It is deplorable that this work was only published in Hungarian and so failed to produce that international reaction which it would have deserved well both for its inherent values and the form of presentation. Otherwise also after the publication of that book, the *Dendrocoelum lacteum* continued to be GELEI's favourite material in which he studied mainly spermiogenesis, and in general, the development of germ-cells respectively. As a result of his studies in this subject he published his most valuable paper which still commands the respect of cytologists and whose title is „Longitudinal Pairing of Chromosomes". In this work he describes the various phases of meiosis systematically, with great lucidity, and in a perfectly novel manner. In the beginning, the work aroused extreme indignation and was strongly criticized in international literature; after some time, however, justice was done to GELEI, and his conclusions have got into the special literature as lasting values. At the time of his professorship in Szeged he turned his attention towards the unicellular organisms, and for the rest of his life was dealt with the *Ciliata,* their taxonomy, morphology, phylogeny, and mainly with their nervous system. With various dry and wet argentation methods, developed experimentally partly by him, partly by his pupils, he showed in a most convicing way the stimulus conduction system of the *Ciliata,* mainly of the *Paramecium,* in which he distinguished — similarly to the nervous system of multicellular organisms — a central and a peripheral system of silvery lines. It is an interesting fact that while — as a pupil and follower of APÁTHY — he professed continuity in respect to the nervous system of multicellular organisms, he saw contiguity in the contact form

between the central and peripheral silvery line systems. Hungarian and international journals, study tours and activities abroad speak of GELEI's work and achievements.

GELEI was not only a good researcher and a good teacher, he was a good organizer at the same time. Shortly after he had been put in charge of the Institute of General Zoology and Comparative Anatomy, he tried to find ways and means for securing to his Institute a better and more spacious accommodation, and to complete properly the rather scanty pool of instruments. And he succeeded. Shortly after the division of the Department, the building of the Discount Bank, which at the time was owned by the State Railways, went over into University ownership. This offered ample opportunity for the Institute to get an accommodation as required by its future and development, and half of the ground-floor space, which looks on Batthyány street, was reserved for the Institute of General Zoology and Comparative Anatomy. GELEI equipped the new premises gradually but fairly quickly and in an attractive manner. He ordered practical, lasting and elegant pieces of furniture, and also equipped the tidy institute with plentiful research instruments in a short time. All this was made possible by a liberal assistance on the part of the State to fill all gaps; but both the making of equipment and the purchase of instruments was greatly promoted by a considerable financial grant given to the new institute by the American Rockefeller Foundation. Within a few years the institute was excellently equipped with all means and devices required for instruction and usual at that time, and was even able to offer comfortable working-places and excellent facilities to researchers coming from abroad. The pool of instruments was completed by a rich zoological collection, most of which came from the vertebrates and invertebrates living in the area of Szeged and the surroundings. There were in addition a considerable number of dry and wet preparations which made possible high standards of instruction in comparative anatomy.

In developping and equipping of the Institute of General Zoology and Comparative Anatomy, GELEI was greatly helped by JENŐ MÁTYÁS, his former junior lecturer, who also had come from Kolozsvár where he was APÁTHY's assistant as well. While in Kolozsvár, JENŐ MÁTYÁS began studies in comparative osteohistology and produced most interesting results in this field whereby he was not only able to differentiate from one another the various bones histologically, but could identify also racial differences in the system building up tubular bones. GELEI attached great importance to the investigations of MÁTYÁS and therefore assigned in shaping the workingprogram and the entire layout of the Institute a considerable role to MÁTYÁS's ideas and illustrations which almost completely covered the walls of the large corridors. JENŐ MÁTYÁS continued his osteological and histological studies with great diligence in the new institute as well and some of the students co-operated in this work actively. After his retirement, JENŐ MÁTYÁS went to Budapest to the Anatomical Institute and summed up the results of his comparative osteohistological studies. This work was published in German by the Hungarian Academy of Sciences.

JÓZSEF GELEI was in no way inferior to his master ISTVÁN APÁTHY as concerns the education of the new generation. Despite the fact that there were few students at that time, GELEI succeded in training a team of researchers which greatly contributed to making known the *Ciliata* of Hungary both structu-

rally and systematically. With the exception of Miss JULIA VIDACS who studied comparative osteohistological problems under the guidance of MÁTYÁS, all the members of the Institute became enthusiastic and competent researchers of the *Ciliata.* PÉTER HORVÁTH, a member of GELEI's school, who later took up teaching in secondary schools, has studied the nervous system of the *Paramecium* and developed a simple argentation method for this purpose which was used successfully at that time. JÁNOS HORVÁTH also studied the nervous system of the *Ciliata;* later he was transferred to the Biological Research Institute of Tihany where he started studies of unicellular fungi. He continued research work in this field also later, as professor of microbiology in the Agricultural University of Gödöllő, till his death in 1969. Miss JOLÁN STILLER studied the *Peritricha* and continued this work also later when she was research worker of the Zoological Gallery of the National Museum. BÉLA PÁRDUCZ studied the stimulusconduction system of the *Ciliata* and was particularly interested in ciliary movement. He investigated motivation and causes of that with particular technical skill and competence. He continued these studies in the Zoological Gallery of the Hungarian National Museum till his early death. GÁBOR GELEI, the son of JÓZSEF GELEI, belonged to the protistological school of Szeged, and was a diligent and competent researcher of the subpellicular system of the *Paramecium.* He continued this work as professor of zoology in the Teachers' Training College of Eger till his early death.

JÓZSEF GELEI worked till summer 1940 as director of the Institute of General Zoology and Comparative Anatomy in Szeged. He then went back to Kolozsvár, taking with him a considerable proportion of the equipment of the institute and all the books which had formerly been brought from Kolozsvár to Szeged. After the departure of GELEI, AMBRUS ÁBRAHÁM was appointed to head of the Institute which then was named upon the recommendation of GELEI, without reason and necessity — „Department of General Zoology and Biology".

AMBRUS ÁBRAHÁM was born at Tusnád on November 20, 1893. After completing secondary school studies he immatriculated at the Philosophical Faculty of the University of Budapest where he acquired a diploma as secondary school teacher of natural history and geography, and a Doctor's diploma of zoology, botany and geology. Still a student, he got into the University Institute of General Zoology and Comparative Anatomy and Histology where he was appointed to professor's assistant, later junior lecturer then privat-docent. In 1934 he was appointed to professor of zoology in the Teachers' Training College of Szeged, and became its director in 1939. He started his scientific research work with the study of the comparative histology of the nervous system, and was active in that line also later on. He was interested in the entire animal kingdom and in man as well, particularly in the nerve supply of the organs of sense, and the cardiovascular system, the sympathetic nervous system and the synapses. Hungarian and international journals, monographs published in German and English, and lectures given at international meetings bear witness to his results in comparative neurohistological work. He was member of 26 international congresses and symposiums, and delivered 42 lectures at these and at other scientific meetings abroad. After starting his educational and research work, he reorganized the institute which then consisted of more than 20 rooms, modernized it as required by the time and equipped it with materials and implements needed for

research work of the nervous systems. During his directorship the field of hydrobiology and cytology was added to histological research, and cytological research produced considerable achievements in respect of unicellular organisms. His institute was abundantly supplied also with comparative anatomical and systematical collection. The collection comprising the avifauna of Fehértó and the insectifauna of Marostő were very interesting and beautiful and were highly useful in the instruction concerned with the fauna of Szeged and surroundings. Equally beautiful were the bone collection and the collection of alcoholic preparations, and the latter, comprising all systems of organism, were available in great numbers to lecturers and practice leaders alike. All this was completed by over 30 thousand neurohistological preparations extending over the entire animal kingdom and the totality of organism produced partly by ÁBRAHÁM himself, partly by his pupils; this collection is unique even by international standards.

Considering the fact that in the forties the number of students of biology was hardly five or six in a year at the Faculty of Natural Sciences in our University, the training for school presented a difficult task to AMBRUS ÁBRAHÁM. Difficulties were increased by the circumstance that while the institute hardly had two or three assistants, it was always his institute that was affected hardest by staff reductions. But even so, if only somewhat belatedly, ÁBRAHÁM succeeded in developing an institute which ranked among the first ones of the world in respect to scientific and research standards. He successfully educated a staff of young, enthusiastic neurohistologists, and in addition, a number of specialists active in other fields of zoology, who have become competent representatives of their respective branches. Owing to the adverse turn of circumstances anyway, they are at present not all in the position to work in the fields for which they have been educated. SÁNDOR BENDE, Miss ARANKA STAMMER, EMIL MINKER, IMRE HORVÁTH, LAJOS ERDÉLYI, JÓZSEF TÁNCZOS, Miss MAGDOLNA FERENCZ, FERENC VETŐ, Miss MÁRIA CSOKNYA, IMRE ROJIK and GÉZA TÚRY have been active in neurohistology; JÁNOS MEGYERI, FERENC BICZÓK and DÁNIEL GÁL have done hydrobiological research work MIHÁLY WEBER, and LÁSZLÓ VARJAS have worked in the entomological field; Miss JUDITH GERGELY and ENDRE VÁGÁS have studied evolutionary and biological problems.

SÁNDOR BENDE started his research work with the skull of fish and continued it with the brain of fish. Later on he started to study the neurohistology of the intestinal canal of fish, and is carrying on these studies at present in Eger where he is senior lecturer and head of the Zoological Department in the Ho Shi Minh Teachers' College. His main concern in to find out whether food, on nutrition, affects the formation of innervation, and, if so, whether this can be detected in the various structural formations.

Miss ARANKA STAMMER studies the innervation of the eyes, respiratory organs and endocrinous systems of vertebrates. She is mainly interested in fine nerve end-structures, her principal subjects being the ganglion ciliare, the pineal organ and the retina. As senior research worker she is now active in the Zoological Department of the University of Szeged.

EMIL MINKER studied the innervation of the intestinal tube of the leeches and of the hinges of shells. Following this he started synaptic research of the paravertebral ganglia. At present he is senior lecturer in the Pharmacological Institute of the University Medical School of Szeged.

IMRE HORVÁTH investigates the structures and evolution of the sympathetic nervous system; his principal field of research is the heart, intestinal canal and truncus sympathicus of the lower vertebrates. At present he is junior lecturer in the Zoological Department of the University of Szeged.

LAJOS ERDÉLYI first investigated the innervation of the cardiovascular nervous system of mammals; later on he started to study the heart of snails and ionic effects. At present he is junior lecturer in the Zoophysiological Department of the University of Szeged.

JÓZSEF TÁNCZOS had dealt with the innervation of the intestinal tube of snails, then he started to study the nerval connections of the gallbladder of mammals. At present he is junior lecturer in the Zoological Department of the Teachers' Training College of Szeged and studies the sympathetic nervous system of *Gastropoda.*

Miss MAGDOLNA FERENC has studied the nerve supply of the intestinal tract of tadpoles. At present she is junior lecturer in the Zoological Department of the University of Szeged where she investigates the fauna of the benthos and the *Oligochaeta.*

FERENC VETŐ studied the neurosecretory nuclei of the hypothalamus of lower vertebrates; at present he is research worker of the Biophysical Institute of the University Medical School of Pécs.

Miss MÁRIA CSOKNYA studied the innervation of the intestinal canal of birds with special regard to conditions of nutrition. At present she is assistant in the Zoological Department of the University Szeged where she is concerned with the anatomy and ecological study of *Ephemerids.*

GÉZA TÚRY studied the anatomy and histology of the brain of the Anura; at present he is junior lecturer in the Zoophysiological Department of the University of Szeged. — IMRE ROJIK studied the innervation of the lactiferous glands, and was mainly interested in the receptors. At present he conducts plant-genetic studies in the special group for genetics of the Zoophysiological Department of the University of Szeged. — JÁNOS MEGYERI investigated the fauna of the natron lakes in the Great Hungarian Plain, and is mainly interested in lower crayfish. He carries out his investigations in the Zoological Department of the Teachers' Training College of Szeged as professor of zoology.

FERENC BICZÓK was first engaged in entomology, after which he started research work with the *Rhizosphaera:* at present he is senior lecturer of the Zoological Department of the University of Szeged and carries on cytological studies in unicellular organisms. — DÁNIEL GÁL studied the *Protozoan* fauna of the dead-waters in the surroundings of Szeged and of the river Tisza. His main concern were the *Rhizopoda;* at present he is research worker of the Zoological Department of the University of Szeged and studies the *Protozoan* fauna of the Tisza.

MIHÁLY WEBER studied the anatomy and taxonomy of the dragon-flies; at present he is professor of zoology in the Teachers' Training College of Pécs and studies the *Hypenoptera.* – LÁSZLÓ VARJAS studied the evolution and physiology of insects. At present he is research worker of the Plant-Protection Research Institute of Budapest where he studies insect hormones.

Miss JUDITH GERGELY started her research work with the study of estrogenic substances; at present she is senior lecturer of the Pharmacological Institute

of University Medical School of Debrecen where she engaged in virology. — ENDRE VÁGÁS studied the evolution of tissues and microtechnique; at present he is junior lecturer of the Zoological Department of the Ho Shi Minh Teachers' Training College of Eger.

After the retirement of AMBRUS ÁBRAHÁM in August 1967, the General Zoological and Biological Institute was merged with the Institute of Zoological Taxonomy and the institution thus created has been named „Institute of Animal Organology and Taxonomy". At the same time the Institute of Animal Physiology was established and OTTÓ FEHÉR was appointed to its director as senior lecturer. OTTÓ FEHÉR was born in Debrecen on February 4, 1927. He studied in the University Medical School of Debrecen; after some time he was appointed to assistant, then junior lecturer and later senior lecturer at the Physiological Institute of Debrecen. His research field is the physiology of the nervous system. Earlier he studied sympathetic ganglia and at present he is engaged in the elementary processes of the auditory cortex.

BÉLA FARKAS, director of the first Hungarian Institute of Zoological Taxonomy organized in Szeged, was born at Hajdúnánás on June 15, 1884. He studied natural history and geography at the University of Kolozsvár. After completing his university studies at the Faculty of Natural Sciences he was elected assistant and then junior lecturer of the Zoological Institute. In 1924 he was appointed to director of the newly established Department of Zoological Taxonomy. Actually he was a histologist, a pupil of ISTVÁN APÁTHY, one of the most skilled in APÁTHY's technique and one of the most talented ones. During his work at Kolozsvár as assistant and then junior lecturer, he studied mainly the intestinal tract of the river crayfish and published interesting conclusions about the histological structure of the digestive glands. Later on with the help of ISTVÁN APÁTHY he was sent to the zoological station in Naples where he published remarkable papers on the histology of sponges. In Szeged he turned his attention to the auditory organ of fish, and this was the line he followed and practised with great diligence and competence during practically all his research activitites. He studied the membranous labyrinth and the sensulae of a great variety of freshwater bony fishes, and tried to clarify with his extremely refined mircotechnical methods the correlations between sensory cells and the nervous system. Shortly after his appointment his institute could move to the building of the Discount Bank — to the ground-floor section looking on Partizán street — and there he established a large institute for zoological taxonomy. Substantially the equipment of the institute was similar to that of the Institute of General Zoology and Comparative Anatomy, with the difference that here the zoological collection was much larger and occupied practically half of the large premises.

Like JÓZSEF GELEI and AMBRUS ÁBRAHÁM, he displayed great diligence and devotion in the development and enrichment of the institute. In addition, he tried to demonstrate, mainly with the composition of the practical material and the selection of subjects, that parasitology, which was rather neglected in Hungary at that time played a highly important role among the biological subjects. How very much right BÉLA FARKAS was in this respect was decisively proved by subsequent trends in international biological research, and is still being proved at every turn. In summer 1946 BÉLA FARKAS resigned from the directorship of the Institute of Zoological Taxonomy, and that involved the liquidation,

or, more exactly, the merger of the Institute with the General Zoological and Biological Institute.

In his efficiently organized and well-equipped institute BÉLA FARKAS provided a possibility for the education of experts, as well who were somewhat detached from the zoological disciplines which he himself mastered. The entomologist GÉZA ZILAHI SEBESS, the malacologist ANDOR HORVÁTH, the protistologist JÓZSEF KORMOS and the parasitologist BÉLA EDELÉNYI were trained in his institute.

GÉZA ZILAHI SEBESS, the outstanding expert of insects and competent researcher of the *Diptera,* graduated from the University of Debrecen and was working there for some time. Later he was junior lecturer of the Institute of Zoological Taxonomy and the General Zoological and Biological Institute of the University, Szeged. He moved from Szeged to Debrecen again where he was senior lecturer and head of the Zoological Institute of the University till his early death.

ANDOR HORVÁTH, a competent researcher of the *Molluscs,* worked as professor's assistant in the Institute of Zoological Taxonomy. As a junior lecturer he later was transferred to the General Zoological and Biological Institute, and then again went back to the Institute of Zoological Taxonomy. At present he works as senior lecturer in the Zoological Department of the University where he studies the Hungarian recent and Pleistocene fauna of *Mollusca* with special regard to ecological features.

JÓZSEF KORMOS is an industrious researcher of the morphology and taxonomy of the *Suctoria,* interested mainly in problems connected with reproduction. He started his work in the Institute of Zoological Taxonomy of the University Szeged, was then active in the Genetical Institute in Budapest, and is at present senior research worker of the Zoological Department of Szeged. — BÉLA EDELÉNYI studied the worms of Hungarian frogs; he carried on this work in Eger where he was senior lecturer of the Zoological Department of the Ho Shi Minh Teachers' Training College. At present he is head of the Zoological Department of the Agricultural University Debrecen and studies the worms of fishes.

The Department of Zoological Taxonomy was reestablished in 1954, and GÁBOR KOLOSVÁRY, as a university professor, was put in charge of the institution.

GÁBOR KOLOSVÁRY was born at Kolozsvár on August 18, 1901. After his secondary studies he immatriculated at the Medical Faculty of University which was moved from Kolozsvár to Budapest and then to Szeged. After passing his first university examination he went over to the Faculty of Natural Sciences where he obtained a leaving certificate in the special subject group of natural history and geography. His scientific activities comprised practically all fields of zoology and biology. He studied zoological taxonomy, ecology, animal psychology, theoretical biology, maritime biology, zoogeography and paleontology. He was particularly interested in fish, spiders and crayfish. His work is evidenced in a variety of Hungarian and other journals.

In the second half of his life he was chiefly concerned with paleontological problems, many of which he presented in a new light and in connection of which he drew conclusions useful also in practice.

In recent years a considerable proportion of his scientific research activities were concentrated on the river Tisza. This river was his favourite research area also in his young days which is evidenced by his monograph written on the fishes the Tisza and on the ways of fishing in that river. Aided by the Hungarian Academy of Sciences, he recently has organized an efficiently working community for studying the Tisza and its flood area („Tisza Research Community"). JÁNOS GAUSZ, LÁSZLÓ GALLÉ, Jr., and GYÖRGY CSIZMAZIA co-operated in this work in addition to the members of his Institute. — JÁNOS GAUSZ, who was mainly concerned with ecology and physiology of the *Orthoptera,* is working at present in the Genetical Section of the Biological Research Center of the Hungarian Academy of Sciences Szeged.

LÁSZLÓ GALLÉ, Jr., who studies the ants of the flood area, worked first in a secundary school of Szeged and now in the Zoological Department of the University Szeged. He has recently started studying the ants of Hungary. — GYÖRGY CSIZMAZIA, who is teacher in secondary school of Szeged, is studying the small mammalian fauna of the flood area, particularly of the dikes and is interested mainly in ecological problems.

Up to August 1967, GÁBOR KOLOSVÁRY was head of the Department of Zoological Taxonomy; from that year he was director of the newly created Institute of Animal Organology and Taxonomy till his death in 1968.

After KOLOSVÁRY's death LÁSZLÓ MÓCZÁR, head of section in the Zoological Gallery of the Hungarian National Museum, was appointed as a university professor to the above mentioned Department. LÁSZLÓ MÓCZÁR was born at Kiskunfélegyháza on December 10, 1914. He studied at the Faculty of Natural Sciences of the University of Budapest, started his scientific work with studying the *Hymenoptera,* mainly the *Aculeata* and is active more or less in this field also today. He is an acknowledged expert and excellent researcher of this order of insects. He has been head of the Institute of Animal Organology and Taxonomy since October 1969. This name was however, abolished in 1970, and the institution was named Zoological Department.

If we look back at the 50 years of the Zoological Department of the University, we see that periods of evolution and involution have alternated in quick succession in the life of the Department. After a long chain of great conceptions and respectable initiatives, this Department, which was called the Zoological Institute at the time of its foundation, has deplorably grown down again to its original form. It goes without saying that in this form it is no longer able to provide an adequate basis for understanding and solving great biological problems. There is no substantial teaching and research work of comparative anatomy and histology in this Department, as this is not possible in the present form. Only the morphology can give strong basis for understanding and solving any biological problem. It has been the basis in the past, is it today, and will be in the future. Biological research of our age is directed by the conception of comparison and phylogeny. And these fields can be approached with any prospect of success only by those who are in possession of perfect and detailed knowledge in comparative anatomy and histology. In universities abroad there are special departments not only for comparative anatomy, comparative histology, but also for comparative neurology, or as it is called in America, for the neurological sciences (neuro-sciences).

In Hungary the only efficient department of comparative anatomy and histology has been dissolved quite irrationally and unreasonably, however the comparative anatomy and histology are basic disciplines and requirements of our time.

We are confident that the time will come — and fairly soon — when the department of comparative anatomy and histology is re-established, when a department of comparative neurology is founded, and the departments of animal physiology and zoological taxonomy are maintained in working condition correlated with the former ones. The idea on whose basis the department of animal physiology came into being was correct and was one of the exigencies of our time.

But it is all the more a requirement of our days that there should be in the future a department of comparative anatomy and histology in the University of Szeged, a department of comparative neurology, a department of comparative physiology based on these and able to develop on this basis, as well as a department of zoological taxonomy paying attention to ecological and zoogeographical features as well. If these four departments become reality, and will be headed by men who are well-versed in the methods of scientific research, have a sence for research work and are able to teach on a high level which is worthy of the name and reputation of our University, then the combined efforts of these four departments will be able to lay the foundations for a zoological and biological erudition on which anybody can rely wherever he be, in whatever circumstances he may get into contact with problems arising frequently and summarily in the field of biology in our days. We are confident that evolution which appeared in a most heartening form in the history of the Zoological Department of the University of Szeged, but turned abruptly into involution, will again start on the road to evolution before long.

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Acta Biologica Szeged 17 (1—4), pp. 29—34 (1971)

HISTORY OF THE ANTHROPOLOGICAL DEPARTMENT (1940—1971)

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(Received Juli 10, 1971)

The varied history of Hungarian physical anthropology saw a period of flourish in the 1940's, indicated also by the establishment on October 19, 1940 of the „Institute of Anthropology and Race-Biology" in the Faculty of Mathematics and Natural Science of Szeged University. The data concerning the period 1940 to 1959 have been compiled by first assistant GYULA FARKAS. The rather ominous term „race biology" *had to be included* — according to L. BARTUCZ's words — in the name of the new institute; but thanks to the progressive thinking of the teachers, the Department kept clear of that line.

As is usual with everything just born, the first steps were not easy. During the first 5 years were working with university professor LAJOS BARTUCZ mainly unpaid assistants (JÓZSEF NEMES, JÓZSEF PÁLFI, ZOLTÁN HEGYES, ALADÁR BARTÓK-CSATHÓ), and it was only from 1944 that the Department was granted of one single assistant position occupied by Dr. KÁROLY TESSZÁK till 1954.

The Department was accomodated in the central building of the University (Dugonics square) and had to face in the beginning not only a shortage of space but also financial problems. Nor was staffing a simple question since no special training of physical anthropologists was going at that time. The Institute was not spared by the war, either, one of its most talented junior assistants, JÓZSEF NEMES, falling victim to war events.

A doubtless favourable event of that period was that professor LAJOS BARTUCZ was elected Dean of the Faculty of Natural Sciences for the academic year 1943—44.. The interest of students in anthropology has been evidenced by that from its foundation up to the end of 1944 the Department had 504 students coming from the circles of biologists, physicians and jurists. The Scientific Institute of the Great Plain (Alföld) within our Institute was established on professor BARTUCZ's initiative with very modest financial support; and in its two yearbooks the researchers reported on the scientific investigations of the manifold (ethnografic, natural) phenomena of the Great Plain.

After the liberation of Hungary, the Institute started on a way of considerable progress. Also its name was modified to Anthropological Institute. This first period lasted till 1951. Although there was no notable development in respect of staff, the Institute met with recognition within the University manifested in professor BARTUCZ's repeated deanship of the Faculty of Natural Sciences in the academic year 1945/46, as well as his position as the acting director

of the editorial staff of the Yearbook of the Biological Institutes at the University of Szeged in 1950, etc.

In that period there were lectures in the Department on general anthropology, anthropology of human races, Hungary's ethnic anthropology, criminal anthropology, social anthropology and systematic anthropology for students of the liberal arts, of law, of the teachers training institute and of medicine. In those years teacher trainees attended lectures on anthropogenesis, palaeoanthropology and general anthropology for four semesters in 5 theoretical and 2 practical lessons a week.

Compositon of the staff did not change notably, only Miss ILONA BOROS as an illustrator and — for two years — Miss KLÁRA STESSEL as an unpaid assistant were active in the Institute in addition.

This was the period when the first scientific plan was drawn up, aimed chiefly at the study of the anthropology of prehistoric age, of the migration period, and of the time of Hungary's conquest. The realization of this plan was doubtless impaired by the fact that the Scientific Institute of the Great Plain (Alföld) had been dissolved in February 1950.

Between August 10 and 27, 1951, the Institute moved to the ground floor of the building at Táncsics Mihály street, to a considerably smaller area. This caused great difficulties in the accomodation of the anthropological collection grown considerably by that time, and resulted in a drawback in the work of the Institute. The next period in the history of the Institute opened in 1951 and lasted till 1950.

The difficulties of that period resulted mainly from that in the academic year 1950/51 the teaching of a class of 124 teacher trainees in biology and chemistry was started, imposing an increased burden on the Institute, as well. This situation was eased but temporarily by that in 1953 the teacher trainee GYULA FARKAS was employed in the Institute as a demonstrator. The earlier established position of an assistant was abolished in September 1954, and Miss ILONA SZILÁGYI, who had been active succesfully since the foundation of the Institute in questions of administration, organization, teaching and research alike, also retired in January 1955.

In February 1955 a professor's assistant was again added to the staff in the person of GYULA FARKAS. Thus beginning from that year, up to 1959, the permanent staff of the Institute consisted of two teachers and two assistant workers. Teaching was going on mainly in the branches of biology-geography and biology-chemistry where the principal aim was the acquisition of an up-to-date knowledge in hominid evolution in compliance with the new requirements. The number of theoretical lessons, however, was reduced gradually and the subject, formerly extending over four semesters, was reduced to one semester. Professor BARTUCZ was comissioned with writing the lecture notes „Anthropology" and „Anthropogenesis and fossil Man", published in 1952 and 1953 respectively. These lecture notes were used as „central" notes at all the three Universities for the respective branches.

Research work continued to be limited mainly to the field of palaeoanthropology, but in 1952 ethnic anthropological studies were resumed, and in 1958, as a new topic, also the investigations of physical growth. All this was supported, apart from the University budget, by a special credit — even if not in

a large amount — of the Hungarian Academy of Sciences. One of the achievements of that period is also the establishment of the Special Section for Physical Anthropology of the Hungarian Biological Association in 1952, professor BARTUCZ, head of the Szeged Institute, being elected to be its president.

In that period the Institute also paid attention to the training of anthropologists, as a result of which two pupils of professor BARTUCZ, GYULA DEZSŐ and GYULA FARKAS, chose physical anthropology for their vocation.

In 1959 professor BARTUCZ was appointed to university professor and head of the Anthropological Institute of the Lorand Eötvös University in Budapest. For a year, the Anthropological Institute in Szeged was directed by professor GÁBOR KOLOSVÁRY, head of the Institute of Zoosystematics. That interim period lasted till March 1960, when museologist PÁL LIPTÁK, holder of a candidate's degree (from the Anthropological Collection of the Museum of Natural History, Budapest) was appointed by the Ministry of Education to reader and head of the Department. This event marked the beginning of a new period of prosperity in the history of the Institute.

The very first task was to increase the staff number because, besides the head of the Department, only one assistant, one laboratory technician and one office attendent were active in the Department at that time. There was not even an administrator in the beginning. From 1961 to 1963 the Department had got only a part-time administrator, being developed into a full-time post from August 1, 1963. Another improvement was that in 1967 the administrator Mrs. EMMA MOLNÁR was transferred from the Philisophical Faculty to our Department, and started its long overdue rearrangement in the summer of that year. She was promoted to the post of an executive in 1970. From 1968, Mrs. GIZELLA KOVÁCS, retired secondary school teacher of biology, was employed — with minor interruptions — for a part-time post to promote the scientific work of GYULA FARKAS.

In 1961 a teacher trainee of biology and geography, Mrs. ANTONIA BOROS, was commisioned with the work of a demonstrator, as a pupil of professor LIPTÁK; in 1963 she was appointed to research student, in 1964 professor's assistant. Meanwhile Miss JÚLIA NAGY worked as a demonstrator temporarily. In 1962 assistant GYULA FARKAS was promoted to the position of a first assistant.

It was a substantial help in the Department's work that — by the aid of the Hungarian Academy of Sciences — Miss EDITH LOTTERHOF, secondary school teacher of biology and chemistry, employed as a research student, was working at the Institute from Spring 1967 to December 1967. From Spring 1961 Mrs. ILONA FODOR occupied a part-time post for assisting scientific work (to the account of the Scientific Research Development Funds) and worked here with longer interruptions till July 1. 1970. With her departure the Department lost a most versatile worker, proficient in languages and typing. It has not been possible to fill this SRDF post permanently since then.

The laboratory assistant of the Institute retired in December 1960, making possible qualitative exchange. He was replaced by SÁNDOR PÓNYAI, employed first as a Department worker, later as a technician. After his departure to the Rector's Office there were two replacements of person in this sphere of work.

Teaching work has continued to be concerned mainly with the training of teachers of biology-geography and biology-chemistry, completed in 1969 by the education of specialists of physical anthropology within the framework of specialization in experimental biology. Even if on a modest scale, the training

of physical anthropologists proper means considerable progress as it is now possible for the first time to graduate in the University specialists with a qualification in physical anthropology.

It was considered necessary by the Ministry of Education to prepare a new, more up-to-date and not too extensive lecture note (10 printed sheets). The head of the Department dr. PÁL LIPTÁK, was commissioned with this work and in 1962 a local university lecture note was published under the title „Physical Anthropology and Human Evolution". In 1966, the same author wrote under the same title a uniform university lecture note of 15 printed sheets for all the universities in the country. The head of the Institute, University professor PÁL LIPTÁK Academic Doctor of the Biological Sciences (D. Sc), was commissioned by the competent committee of the Ministry of Education, authorizing seven sheets extension of size, to write a university textbook of the size of 22 printed sheets under the title „Physical Anthropology and Human Evolution" that was published in December 1969. This meant substantial progress in the teaching of physical anthropology in Hungary since there existed no special university textbook of physical anthropology in Hungary till that time. Teaching was promoted also by that a local lecture note was edited under the title „Anthropological Practices" by GYULA FARKAS in 1962.

The activity of the new head of the Department brought a certain change to the topics of research work. Pál LIPTÁK has introduced in the historical anthropological (palaeoanthropological) research work his own, so-called „taxonomic method", writing himself, as well, several studies on the elaboration of anthroposystematics based on skeletal material. In the transition period GYULA FARKAS started independent studies of the questions of body growth and development and later co-operated in addition in the evaluation of the very important Bronze Age series. By making use of good relations with the archeologists, the head of the Department devoted great attention to enriching the Institute's cranial and skeletal collections without any financial support.

In the most recent period of the Institute it is a considerable achievement that it has been possible to equip a dry basement as a storeroom with a metal framework construction, and that at last, in 1971, the long-planned laboratory of bone chemistry was laid out and equipped, as well. The latter makes possible to engage in a further line of research work with the support of dr. Med. IMRE LENGYEL as temporary lecturer and the co-operation of GYULA FARKAS.

Meanwhile the palaeoanthropological study of finds from South Hungary was going on systematically and was greatly helped by repeated excavations made in co-operation with archeologists since 1957; these raised the standards of the collection of the Institute. For this we are indebted among others to the understanding support by candidate OTTO TROGMAYER, archeologist in Szeged and director of the County Museum, and to the archeolokists of the Museums in Baja, Hódmezővásárhely, Gyula, Kecskemét and elsewhere. This was the reason, among, others, why distinguished professors and researchers from abroad have more and more often visited the Institute since 1960 (DEBETZ, GINZBURG, TROFIMOVA, OLIVIER, GRIMM, CORRENTI, ULLRICH, SCHOTT, BACH, STLOUKAL, FERÁK and others). Besides palaeoanthropological studies, the research works relating to the ethnic anthropological study of the living population — started earlier but interrupted — resumed again. The results of them were published as

separate chapters in two extensive monographs (monographs of Orosháza and Tápé).

One of the outstanding achievements of the Department's research work was that the author of this article obtained the Academic Doctor's degree of Biological Sciences (D. Sc) by defending his thesis „Palaeoanthropology of the Ethnogenesis of the Ancient Magyars" in January 1969, as a result of which he was appointed to university professor in the same year.

The close connections between teaching and scientific work are characterized by the intensive work of the students' association, the many papers on specialized topics, prepared in the Department, the competition essays submitted by the students, the papers presented with and rewarded by the National Student's Association Conferences. It was an appreciation of the work in the Institute that its leading teacher, first assistant GYULA FARKAS was put in charge of organizing the IXth National Scientific Conference of the Students' Associations.

Another important fact is that, under the guidance of PÁL LIPTÁK, the teachers of the Institute, GYULA FARKAS and Mrs. ANTONIA BOROS, took their examinations for a University doctor's degree. Following that, MISS JÚLIA NYILASI, GYULA DEZSŐ, KÁROLY VÁMOS, MISS KATALIN ZSILKÓ, SÁNDOR WENGER, Miss JÚLIA BAGÁNY and JÓZSEF JANZSÓ defended their doctor's thesis in physical anthropology as the main subject. As a co-examiner and critic, PÁL LIPTÁK took part at the University of Debrecen in the examination for university doctor's degree of OTTO EIBEN (at present frist assistant in the Lorand Eötvös University, Budapest).

During its past of 30 years, the Institute of Physical Anthropology at the Szeged University has achieved a distinguished rank in Hungarian physical anthropology. The participants of this work have won considerable appreciation several times. Thus previously professor BARTUCZ was conferred on, and professor PÁL LIPTÁK acquired by defending his thesis, the degree of an Academic Doctor of Biological Sciences. LAJOS BARTUCZ was awarded to the golden class of the „Order of Labour" in 1964, and GYULA FARKAS the title „Eminent Worker of Education" in 1970. Professor LAJOS BARTUCZ was the president of the Anthropological Section of the Hungarian Biological Society between 1952 and 1956, and professor PÁL LIPTÁK has been its president since 1968. In two periods (about 7—8 years long) during the last decade, PÁL LIPTÁK was member of the General Biological Committee of the National Postgraduate Degree Granting Board, as well as of the Biological Committee operating at the Ministry of Education. PÁL LIPTÁK has been member of the Anthropological Committee of the Hungarian Academy of Sciences since its existence, GYULA FARKAS since 1966, and he has been its secretary since 1970.

A close co-operation has been established with the archeologists and anthropologists of the neighbouring Yugoslavia, and teachers of the Institute (GYULA FARKAS and Miss EDITH LOTTERHOF) have co-operated in international excavations in the Voivodina on this basis.

The teachers of the Anthropological Institute took part in congresses, conferences and study tours abroad several times. Of these we only mention the most important ones. PÁL LIPTÁK: Bulgaria 1956, Paris 1960, Moscow 1961, Helsinki 1965, United Kingdom 1970, Tallinn 1970, where he gave lectures, too.

GYULA FARKAS: Poland 1966, Yugoslavia 1969, German Democratic Republic — several times.

Summing up, we may conclude that the results of the 30 years' work of the Anthropological Institute have been brought about by the secondary-school teachers diplomas, by the university teachers and researchers passed from among them, and they consist of a large number of studies. It appears beyond any doubt, anyway, that the initiative to create the Anthropological Institute in the University of Szeged turned out to be right, it being in 1971 in Hungary the only really independent university department, headed by a qualified anthropologist with scientific degree. Thanks to the understanding of top- management, it was partly possible to remedy the backwardness of the first decades in recent years. The perfect solution as regards staff, finances and equipment is a task of the near future.

Finally we should like to give a brief account of the publishing activities of the research workers in the Department.

Between 1940 and 1971 — before compiling this report — the teachers working in the Institute published altogether 138 papers. Of these publications LAJOS BARTUCZ wrote 28 (between 1940 and 1971), PÁL LIPTÁK wrote 41 (between 1960 and 1971), GYULA FARKAS wrote 61 — including works of popularization — (between 1955 and 1971), Mrs. ANTONIA BOROS wrote 7 (between 1966 and 1971), Miss EDITH LOTTERHOF wrote 3 (between 1969 and 1971), and KÁROLY THESSZÁK wrote 1 (between 1943 and 1954). It is to be noted that this enumeration does not include some 220 publications — including the many popularizing articles — of LAJOS BARTUCZ, and 30 scientific studies of PÁL LIPTÁK , drawn up not in the Szeged Institute, but at their other places of work. There are also books and university lecture notes among the anthropological works published. LAJOS BARTUCZ wrote 3 books and 2 lecture notes, PÁL LIPTÁK wrote 1 book and 2 lectures notes, GYULA FARKAS wrote 1 lecture note; PÁL LIPTÁK and GYULA FARKAS were co-authors of certain parts in 3 monographs.

These publications have been contained mainly in Hungarian anthropological journals, archeological journals, yearbooks of Museums, in the Acta of University and the Hungarian Academy of Sciences, in congress publications and in anthropological journals and periodicals abroad. For those interested in more details in publication activities of the Department we may refer to the following bibliographies:

IRMA ALLODIATORIS: Anthropological Bibliography of the Carpathian Basin. — Budapest, 1958 (in Hungarian and in German).

GY. FARKAS—GY. DEZSŐ: Bibliography of Hungarian Anthropology (1952—1964). — Anthropológiai Közlemények (=AK) *9*, 1965.

GY. FARKAS: Bibliography of Hungarian Literature in, or Relating to, the Subject of Anthropology (1965). — AK. *10*, 1966.

The same (1966). — AK. *12*, 1968.

The same (1967—1968). — AK. *13*, 1969.

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Acta Biologica Szeged 17 (1—4), pp. 35—48 (1971)

PRODUCTION TESTS IN PLANT COMMUNITIES OF MEADOW-LAND WITH SOLONETZ SOIL II. THE EFFECT OF CLIMATIC AND SOIL FACTORS ON THE DRY-SUBSTANCE, CARBOHYDRATE AND NITROGEN CONCENTRATION IN THE SPECIES OF DRAINING SODIC MARSHLAND

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(Received July 20, 1970)

For several years we have conducted near Nagylak synecological investigations in the plant communities of meadow-land with solonetz soil in order to analyze the effects of climatic and soil factors. In view of the aim of the International Biological Programme, we studied the effect of climatic and edaphic factors on the species composition of 3 selected stands, on the dry-substance, total-nitrogen and total-carbohydrate concentration in the stands and in the dominant species. Our studies corcerning the *Artemisio-Festucetum pseudovinae* stand have been summed up in a previous report (1969).

In this paper we present a report on our studies with *Agrosti-Alopecuretum pōtosum angustifoliae* which forms the second zone, in the draining sodic marshland, of the 3 stands selected (Figure 1).

General characterization of the studied area and the stand

Large sodic meadows and pastures have developed on the slightly solonchak meadow-solonetz soils which are typical of the southern region east of the river Tisza. Prior to the realization of the comprehensive plans of river control and inland drainage, the features of this region were shaped after the spring movement of inland waters by the marshland vegetation of gradually alkalifying flats with stagnant waters.

The system of canalization serving inland drainage dried up these areas at an increasing rate. The effect of level differences became a decisive factor as concerns both habitat circumstances and the growth of the vegetation cover. Dissimilar hydrographic conditions developed also in the case of small level differences and resulted in varied biogeocenoses.

According to the water content and salt conditions, a particular zonation system of the stands emerged on the gradually alkalifying soil. The most intense transformation — also in the Nagylak area — appeared in the sections of higher level. Species characteristic of the original sodic marshland and appearing threadwise evidence the initial stage of succession. Through the processes leading to steppe formation the stand on the benches of the sodic flat has proceeded up to the dry meadow-pasutre type of the *Artemisio-Festucetum pseudovinae* (first zone).

The second zone is the deepest of the sodic flat and comprises the transitional meadow-cenoses between the benches; the third is made up of flats of lower levels still dominated by marshland species and belinging to the meadow foxtail type (Figure 1). Changes in species combination and their causes.

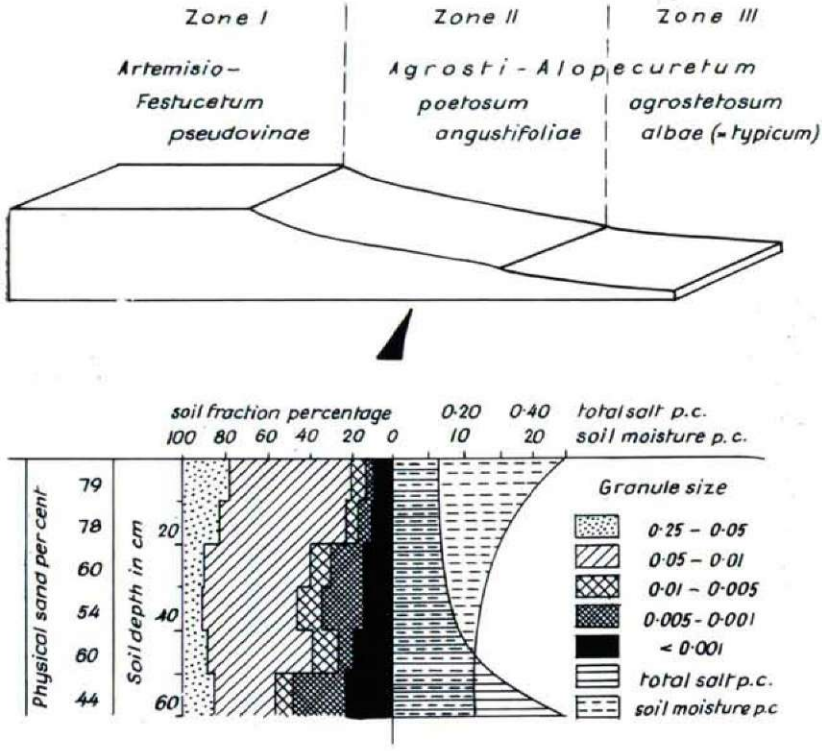


Figure 1. Zonation and soil conditions of the phytocenosis forming the subject of this study

The original *Agrosti-Alopecuretum* species combination underwent a considerable change as a consequence of an increasing drying up of the zone. The salt concentration of the soil increased as a result. This had the consequence that of the *Agrostion* and *Molinio-Arrhenatheretea* species only *Alopecurus pratensis* and *Taraxacum officinale* survived. The accumulation of sodium salt increased as the moisture content of the soil decreased, and this resulted in the appearance of certain *Puccinellion* and *Puccinellietalia* species. The vanishing marshland elements were replaced first of all by *Carex stenophylla* which readily adapts itself to the sodium salts and the low moisture content of the soil. Owing to its poor competitiveness — which is connected mainly with the inadequate moisture conditions — *Puccinellia limosa* was not able to gain any considerable ground. In the autumn season the dominance value of *Atriplex lithoralis* is considerable.

The other trend of succession in connected with the process of steppe formation. The increasing leaching of the *A* level provides favourable living conditions for certain species of the glycophilous steppes. It was in this way that in the spring and summer season *Poa angustifolia* and, later on, *Cynodon dactylon* attained considerable dominance values. Their flat root systems are in the *A* level above the solonetz layers. On the other hand, the appearance of

Table 1. Changes of temperature maxima and minima in the region including the studied area (average of 50 years, between 1901 and 1950)

Tótkomlós	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
max	8,5	12,1	19,4	24,9	29,1	33,3	35,1	34,6	30,6	25,4	17,1	12,1
min	—15,1	—13,0	—6,3	—1,6	3,1	6,9	10,5	8,8	4,6	—1,3	—5,4	—11,5
mean	—3,3	—0,4	6,5	11,6	16,1	20,1	22,8	21,7	17,6	12,5	5,8	0,3
departure from mean in 1968			—0,5	+2,2	+2,1	+0,6	—2,0	—2,3	—0,6	—0,9		

Table 2. Monthly average number of sunny hours

Mezőhegyes	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
(average of many years	60	87	158	190	252	279	325	294	231	171	76	61
1968	56	84	191	238	230	334	299	230	185	145	65	55
departure from average	—4	—3	33	48	—22	55	—26	—60	—46	—26	—11	—6
departure in %		—3,5	+20,9	+25,2	—8,9	+19,5	—7,9	—21,8	—20,1	—16,5		

Table 3. Rainfall conditions

in mm Mezőhegyes	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
30 years average	37	38	37	42	67	83	47	56	42	51	59	45
1968	32,1	30,6	17,9	26,5	60	44	66,7	79	112,5	2,9		
departure from av.		—7,4	—19,1	—1,5	—7	—39,0	+19,7	+23,0	+70,5	.	.	.
dep. in %		—19,4	—51,6	—36,9	—11,4	—47,2	+41,2	+41,0	+209,8	.	.	.

Table 4. Changes of climatic factors in periods between material collecting

	Mar 1 to Apr 25	Apr 26 to May 9	May 10 to Jun 19	Jun 20 to Aug 1	Aug 2 to Sep 5	Sep 6 to Oct 11
No. of days	56	14	41	43	35	35
Temperature max. highest	29,5	33,0	33,5	36,7	29,0	30,5
°C lowest	1,5	20,5	16,4	16,7	16,0	15,0
mean	15,5	25,2	25,1	27,5	24,7	20,7
min. highest	13,2	17,0	20,5	21,6	17,3	18,4
°C lowest	—6,8	6,3	5,5	9,0	8,8	3,6
mean	2,9	12,5	13,1	14,3	14,2	10,4
No. sunny hours						
Szeged	411	144	318	427	241	239
Tótkomlós	413	142	343	455	246	233
daily average %						
Szeged	7,2	9,6	7,8	9,9	6,9	6,8
Tótkomlós	7,2	9,5	8,4	10,6	7,0	6,7
Robits radiation value	10,016	2,775	9,361	10,617	6,868	5,254
Calorie/cm²	18,298	5,321	18,630	21,840	13,764	10,058
Calorie quantity daily average	321,0	354,7	454,4	508,1	393,0	287,4
Rainfall in mm (1968)	34,9	11,9	72,8	83,3	99,8	94,8
daily average in mm	0,62	0,85	1,77	1,93	2,85	2,71

Limonium gmelini indicates the effect of deeper salt layers. Yet for *Festuca pseudovina,* the dominant species of this country's glycophilous steppes, this zone is still too wet and so this plant does not occur here even threadwise.

We conclude as a result of our soil analyses that the original *A* level of the sections opened up to a depth of 60 cm has suffered erosion and can be found secondarily between 0 and 10 cm which has differentiated from the B_1 level.

It is characteristic of the physical structure of this soil that the coarse mud fraction is dominating in 80% of the sections (0,01—0,05 mm ∅).

Based on our synecological studies to date it may be concluded that this is the hardest ground of all soil sections east of the river Tisza.

As concerns the chemical composition, the total salt content in levels A and B_1 does not reach 0,2% and rises to 0,3—0,4% in the deeper B_2 level only in the summer season (Figure 1). Thus it is understandable why a considerable proportion of the species components — which make up the cenosis and have a flat root system for the most part — is a glycophilous species.

The data relating to the characterization of the climatic conditions of 1968, to the temperature, the number of sunny hours and the rainfall conditions are summed up in Tables 1, 2, 3 and 4 and are compared with the averages of many years.

The values of important climatic factors referred to the periods between

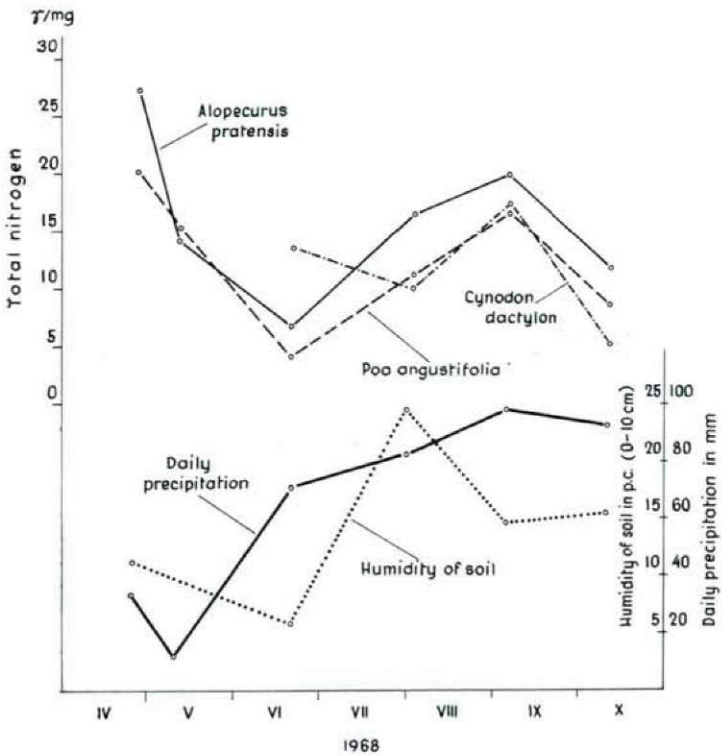


Figure 2. Correlation between the total nitrogen concentration of the three grass species and the changes during the growth season in the percental quantity of rainfall and soil moisture

material collecting have been supplied by the meteorological station of Tótkomlós and are shown in Table 4.

The methods employed in the course of our studies and the literature used have been discussed in detail in our previous publication (1969).

The changes taking place during the growth season in the species composition of the stand are shown in detail by the star diagrams of Figure 5, and the data relating to the dry-substance, total-N and total carbohydrate contents of the investigated species are summed up in Fig. 2., 3., 6a.

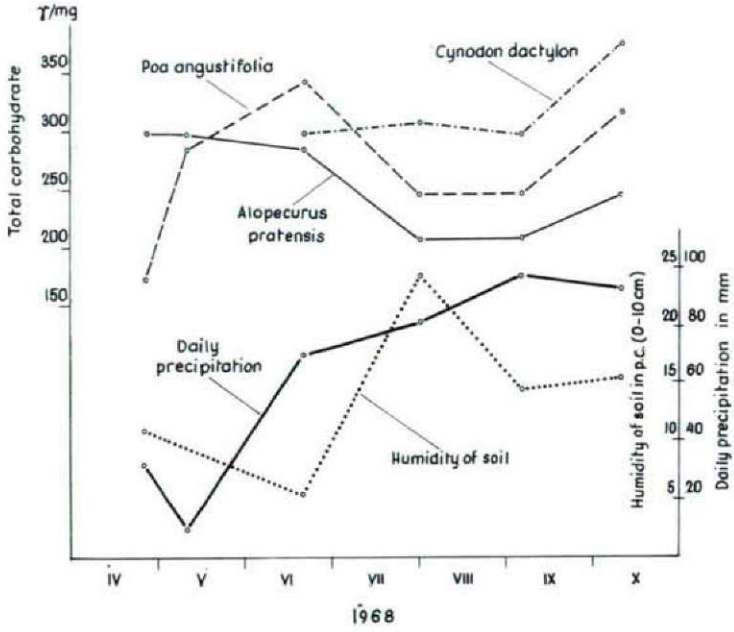


Figure 3. Correlation between the total carbohydrate concentration changes of the three grass species and the changes of the two external factors

Test results

The middle phase of the spring aspect (test date April 26, 1968)

Counted from March, the beginning of the growth season, it has been found that the extreme temperature values showed no considerable departure from the average of many years. On the other hand, the number of sunny hours was much more, and rainfall was much less than the average of many years.

(No soil analysis was made on this occasion)

We selected 7 species from the 11 (including those appearing threadwise) which made up the community. Dominant were *Carex stenophylla, Poa angustifolia,* and *Alopecurus pratensis.*

We measured the highest total-N concentration in *Alopecurus pratensis. Taraxacum officinale* known for its high N content was ranking fifth with its 12 γ/mg value. An outstandingly high total carbohydrate concentration was measured also in *Alopecurus pratensis.*

The post-phase of the spring aspect (test date May 9, 1968)

In the period between the two tests the mean temperature was higher by 2 °C than the average of many years, and the number of sunny hours was also higher. As a consequence of scanty rainfall the dry weather became permanent from March and affected the community particularly in the latter period.

As a result of increased insolation and little rainfall the moisture content of soil was low also in the lower *B* and *C* levels, amounting on the average to 10%.

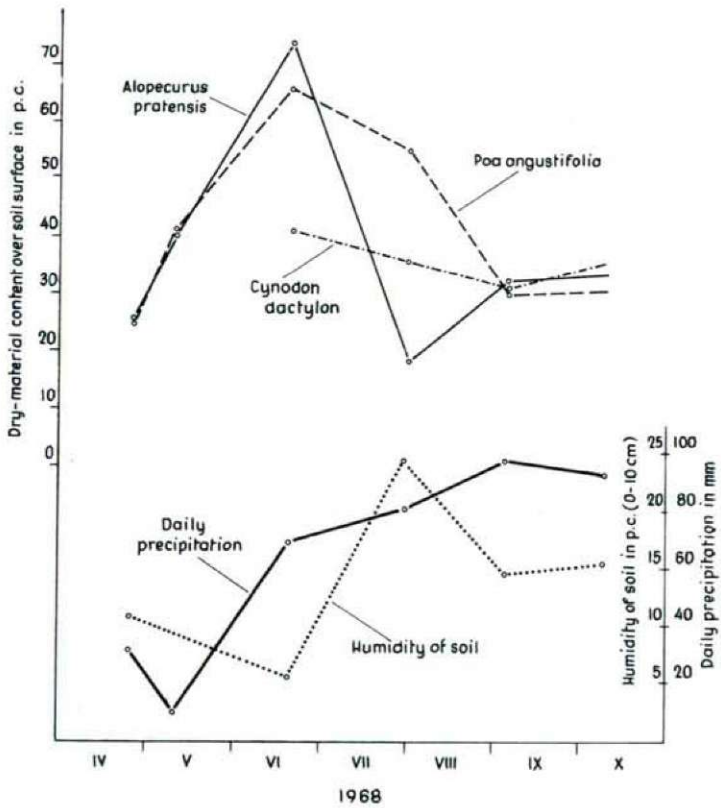


Figure 4. Correlation between the change in the dry-substance content of the three grass species of the studied species combination and the changes of the value of rainfall and soil moisture

As a result of decreasing soil moisture and scanty rainfall the dry-substance content of these species grew considerably compared to the previous analysis.

As a result of the dry period, we found a major change in the N concentration and a minor change in the carbohydrate concentration (Fig. 2., 3).

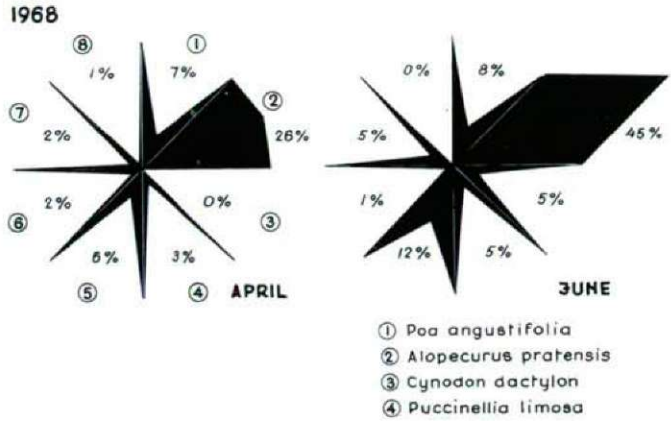


Figure 5. Qualitative and quantitative changes in the species composition of the stand during

The pre-phase of the summer aspect
(test date June 19, 1968)

The temperature was higher by 1,4 °C than the average of many years (13,1 °C), and there were more sunny hours as well.

Compared to the first two periods, there was a considerable quantity of rainfall, but the June rainfall maximum so typical of this country's climate did not come about that year. Rain fell on 4 occasions only and this was not sufficient to moisten the deeper soil layers; their water content decreased further, amounted to 5% in the *A* and *B* levels and reached 10% only in the *C* level.

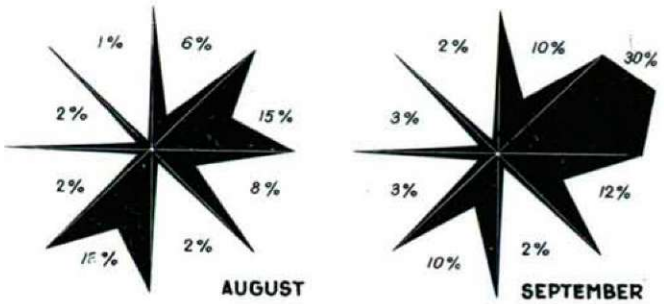
As a consequence of considerable solar energy and insufficient rainfall, clearly xerophilous habitat conditions developed in this marshland zone. The overground portion of most species was largely in a withered state at the time of gathering, hence the average content in dry subsstance was high. (Compared to the previous measurements, increase was 34% in the case of *Alopecurus pratensis,* 25% in the case of *Poa angustifolia,* and 19% in the case of *Carex stenophylla).*

As a consequence of increasing drought there was no winter rainwater supply to the soil; the 3 dominant species shifted their order of succession because the adaptability of the meadow-foxtail as a hygro-mesophilous species is (poorer) than that of the meso-xerophilous blue-grass and sedge. *Cynodon dactylon* showed the greatest adaptability among the *Gramineae* species.

The smallest change in dry-substance content was found in *Limonium gmelini* and *Scorzonera cana,* the two characteristic species of meadow solonetz soils becoming steppe.

Compared to the previous analysis, the total N concentration decreased considerably in all species, while the total carbohydrate concentration changed but slightly.

The main phase of the summer aspect
(test date August 1, 1968)



⑤ Carex stenophylla
⑥ Taraxacum officinale
⑦ Limonium gmelini
⑧ Inula britannica

the growth season

The mean temperature of the 43 days that had passed since the previous collecting was 20,9 °C. The number of sunny hours hardly exceeded the values of the late April and early May period. Because of an increase in the quantity of rainfall, and a decrease of evaporation from the stand due to the withering of plant parts in the preceding period, the water content of the soil increased fivefold in the A level and threefold in the B_1 level. A few per cent of the sodium salts were washed into the B_1 level. (Figure 6b).

The dry-substance content decreased as a consequence of resprouting taking place in most species. This was seen to the greatest extent in *Alopecurus pratensis,* but this may be explained also by the fact that by the action of wind the previously withered sprout portions were broken off.

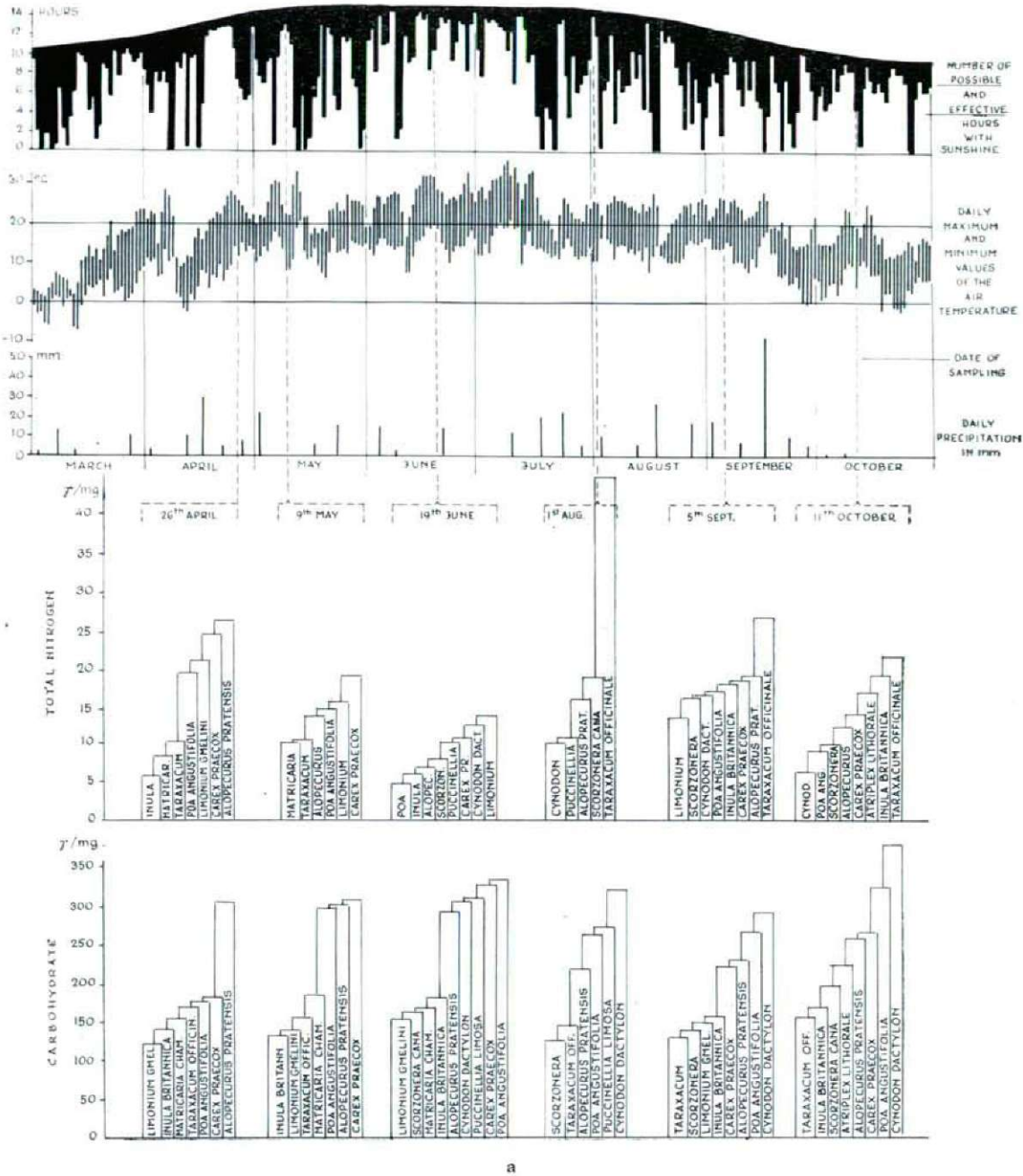
The total carbohydrate content was reduced and — except for two species, i. e. *Poa angustifolia* and *Cynodon dactylon* — was the lowest in the entire growth season at this time.

On the other hand, the N concentration showed more of an upward trend. (It should be noted that no generalization is possible here because we were only able to determine the total N concentration of 4 species at that time).

The prephase of the autumn aspect
(test date September 5, 1968)

The mean temperature was 19,4 °C during this test period. The daily average number of sunny hours was less by three than in the preceding period. The quantity of rainfall was greater and the distribution was even. Tables 1, 2, 3). But under the effect of an increasing evaporation due to a growing phytomass the water content of the soil decreased by some 10%.

As a result of a more favourable climate and soil-ecological factors, also the number of species increased. Compared to the previous analyses, the dry-substance content of *Cynodon* showed the smallest change among the species that made up the species combination in early autumn. The content in other species decreased or increased depending on the extent of resprouting.

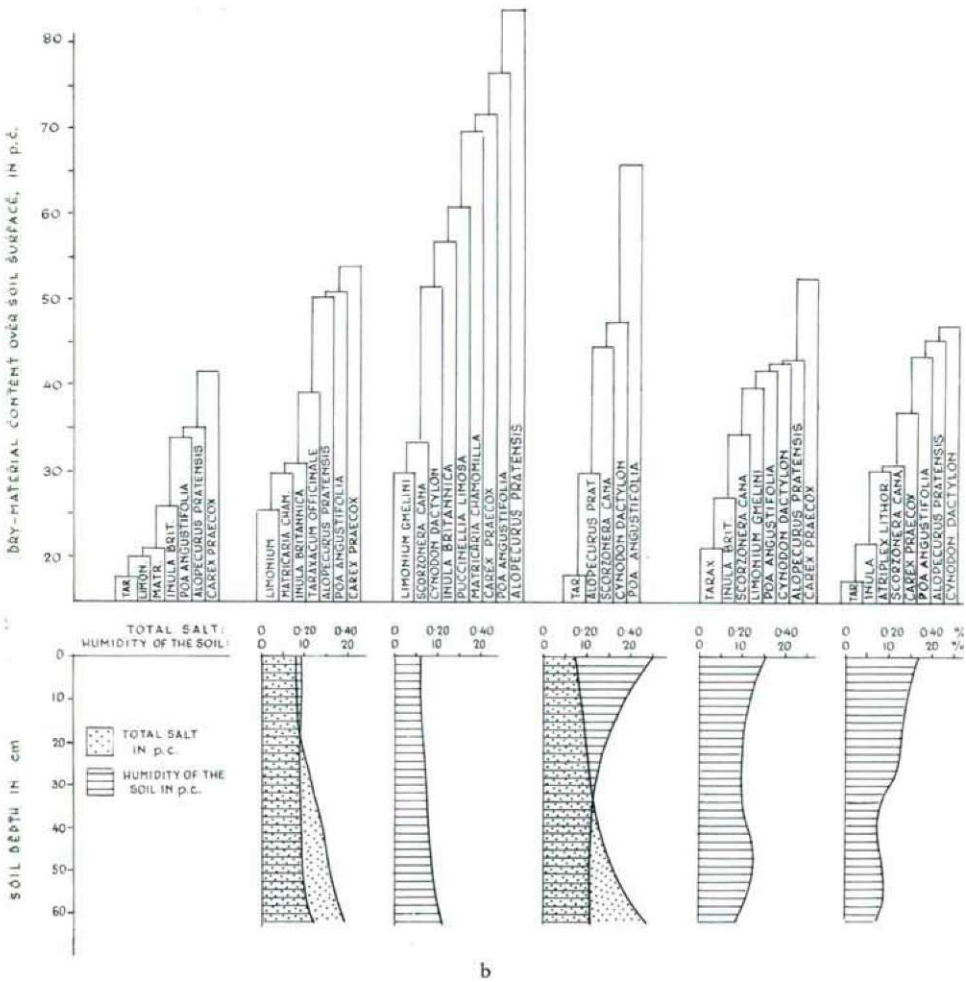

HOURS
NUMBER OF POSSIBLE AND EFFECTIVE HOURS WITH SUNSHINE
°C
DAILY MAXIMUM AND MINIMUM VALUES OF THE AIR TEMPERATURE
mm
DATE OF SAMPLING
DAILY PRECIPITATION IN mm
MARCH
APRIL
MAY
JUNE
JULY
AUGUST
SEPTEMBER
OCTOBER
γ/mg
20th APRIL
9th MAY
19th JUNE
1st AUG.
5th SEPT.
11th OCTOBER
TOTAL NITROGEN
INULA
HYPOCAR
TARAXACUM
POA ANGUSTIFOLIA
LIMONIUM GMELINI
CAREX PRAECOX
ALOPECURUS PRATENSIS
MATRICARIA
TARAXACUM
ALOPECURUS
POA ANGUSTIFOLIA
LIMONIUM
CAREX PRAECOX
POA
INULA
ALOPEC.
SCORZON.
PUCCINELLIA
CAREX PR.
CYNODON DACT.
LIMONIUM
CYNODON
PUCCINELLIA
ALOPECURUS PRAT.
SCORZONERA CANA
TARAXACUM OFFICINALE
LIMONIUM
SCORZONERA
CYNODON DACT.
POA ANGUSTIFOLIA
INULA BRITANNICA
CAREX PRAECOX
ALOPECURUS PRAT.
TARAXACUM OFFICINALE
CYNOD
POA ANG.
SCORZONERA
ALOPECURUS
CAREX PRAECOX
ATRIPLEX LITHORALE
INULA BRITANNICA
TARAXACUM OFFICINALE
CARBOHYDRATE
LIMONIUM GMEL.
INULA BRITANNICA
MATRICARIA CHAM.
TARAXACUM OFFIC.
POA ANGUSTIFOLIA
CAREX PRAECOX
ALOPECURUS PRATENSIS
INULA BRITANNICA
LIMONIUM GMELINI
TARAXACUM OFFIC.
MATRICARIA CHAM.
POA ANGUSTIFOLIA
ALOPECURUS PRATENSIS
CAREX PRAECOX
LIMONIUM GMELINI
SCORZONERA CANA
MATRICARIA CHAM.
INULA BRITANNICA
ALOPECURUS PRATENSIS
CYNODON DACTYLON
PUCCINELLIA LIMOSA
CAREX PRAECOX
POA ANGUSTIFOLIA
SCORZONERA
TARAXACUM OFF.
ALOPECURUS PRATENSIS
POA ANGUSTIFOLIA
PUCCINELLIA LIMOSA
CYNODON DACTYLON
TARAXACUM
SCORZONERA
LIMONIUM GMEL.
INULA BRITANNICA
CAREX PRAECOX
ALOPECURUS PRATENSIS
POA ANGUSTIFOLIA
CYNODON DACTYLON
TARAXACUM OFF.
INULA BRITANNICA
SCORZONERA CANA
ATRIPLEX LITHORALE
ALOPECURUS PRATENSIS
CAREX PRAECOX
POA ANGUSTIFOLIA
CYNODON DACTYLON

a

The total N concentration usually continued to show and upward trend and it was striking to see that it was nearly identical in all species we have studied, with the exception of *Taraxacum*. With the exception of *Scorzonera*, the carbohydrate concentration was nearly unchanged in all species compared to the previous analysis.

Postphase of the autumn aspect
(test date October 11, 1968).

The average daily temperature of the last test period was 15 °C (maximum 30,5, minimum 3,6 °C). The number of sunny hours more or less agreed with



b

Figure 6. Changes of the climatic and edaphic factors, and changes in the dry-substance contents, total nitrogen and total carbohydrate concentrations in the species components of the studied phytocenosis during the growth season of 1968

the average of many years. The first third of this test period was the rainiest of the year, but there was hardly any rainfall in October.

The soil-ecological conditions showed hardly any change compared to the preceding period.

Certain species were absent from the plant community, others — e. g. *Atriplex lithoralis* — appeared.

The dry-substance content showed a downward trend as a rule, with the exception of *Alopecurus pratensis* and *Cynodon dactylon* (Figure 6b).

Except for *Inula britannica,* the total N concentration decreased considerably in the species we studied. On the other hand, the carbohydrate concentration showed a marked increase, particularly in *Poa angustifolia* and *Cynodon dactylon.*

* * *

In the following we present a few important findings of our studies as seen in their correlations with climatic and soil factors:

Dry-substance content

It increases in most species during the growth season, after which it shows a downward trend. Except for *Taraxacum officinale* and *Scorzonera cana,* it is the highest in June.

The dry-substance content shows a correlation through the water content of the soil with the climatic factors, i. e. with rainfall, the number of sunny hours and temperature. This was seen particularly at the test on June 19. Yet this correlation is not exclusive as was evidenced, for example, by the test on August 1. Namely the greatest ground water content of the growth season was found at that time (in the upper 20 cm layer) while the dry-substance content was average.

The dry-substance content shows a correlation with the phenological phases, i. e. it is usually the highest at the time of crop ripening. This internal rhythm acts in certain species more intensely than the water content of the environment. For example, the highest dry-substance content was found in *Scorzonera* in August when the ground water content was the greatest (Fig. 4., 6b).

The percental changes in the dry-substance content are two and threefold in the growth season in the species we have studied, and are nearly identical as concerns proportion. But taken in absolute values, the dry-substance content of grasses is higher than that of the dicotyledons (1,5 to 2 times higher).

The total carbohydrate concentration

The changes of total carbohydrate concentration during the growth season differ considerably in grasses and dicotyledons. There is hardly any change in the latter, even the difference in this respect between the 4 species we have studied is insignificant.

The total carbohydrate concentration is substantially higher in grasses, nearly twice as high as in the dicotyledons. There are 2 types in respect of change. In one type the concentration is increasing till June, decreases afterwards, but increases intensely again at the end of the growth season. (It should be noted that the carbohydrate concentration shows a correlation with the

changes of the dry-substance content only in this type, and that the end of the growth season must be disregarded even in this case).

In the other type the change of the carbohydrate concentration shows an upward trend during the entire growth season. Among the grass species we have studied only *Alopecurus pratensis* differs from these two types; its carbohydrate concentration is high throughout and decreases only to a slight degree.

Thus, in essence, the carbohydrate concentration shows no correlation with the dry-substance content, nor does it show a correlation with the phenological phases.

The correlation of carbohydrate concentration changes with the quantity of rainfall and the water content of the soil is inverse.

Total nitrogen concentration

The total nitrogen concentration is usually in inverse ratio to the dry-substance content: the highest dry-substance content is accompanied by the lowest nitrogen concentration in most cases (especially in grasses).

The total nitrogen concentration is nearly identical in the grasses and the dicotyledon species we have studied. The only exception we found was the very high nitrogen concentration measured in *Taraxacum* officinale on August (it was resprouting in August) but this might have been a measuring error.

In the case of grasses we have found a direct correlation between the total nitrogen concentration and the water content of soil and rainfall.

The changes of carbohydrate and nitrogen concentrations are always opposite in grasses. We have found no correlation between the changes of total carbohydrate and nitrogen concentration in dicotyledons.

Summary

On the basis of synecological studies carried out in a stand of *Agrosti-Alopecuretum poētosum angustifoliae* in the Nagylak area, the following conclusions may be drawn:

1. In most species the dry-substance content changes in the growth season in an increasing direction, and afterwards in a decreasing direction. These changes show a correlation through the water content of the soil with the climatic factors and also with the phenological phases.

In the growth season the percental changes of the dry-substance contents are of indentical proportions in the species studied, but the dry-substance content of grasses is higher (1,5 to 2-fold) than that of the dicotyledons.

2. Total carbohydrate concentration hardly changes in dicotyledons during the growth season, and differences in this respect are insignificant between species.

The total carbohydrate concentration of grasses is substantially higher, and also the changes are of a greater degree.

The carbohydrate concentration shows a correlation neither with the dry-substance content nor with the phenological phases. It shows an inverse correlation with the quantity of rainfall and the water content of the soil.

3. The total nitrogen concentration of the studied grasses and dicotyledon species is nearly identical and shows an inverse correlation with the dry-substance content.

There is a direct correlation between the total nitrogen concentration of grasses and rainfall and the water content of soil.

4. There seems to be no correlation between total carbohydrate and total nitrogen concentration in dicotyledons, while this change is always opposite in grasses.

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Acta Biologica Szeged 17 (1—4), pp. 49—62 (1971)

NORMAPOLLES TAXA FROM PALAEOCENE SEDIMENTS

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(Received February 7th 1969)

Introduction

The genera of Normapolles stemma were elaborate in PFLUG's paper (1953), the description of several species were, however, included in a previous publication by THOMSON and PFLUG (1953). The papers of WEYLAND and GREIFELD (1953) as well as of WEYLAND and KRIEGER (1953) are also of prime importance. Later on, the spore-pollen assemblage of sediments from the Upper Cretaceous period was treated in several works, and numerous data came to light recently. Particularly the monographs of ZAKLINSKAIA (1963), and GÓCZÁN, GROOT, KRUTZSCH and PACLTOVÁ (1967) are noteworthy.

These grains of pollen are the remains of a group of ancient *Angiospermae*, their exine and germinal structure being extremely complicated. In respect of determining the geological age, their occurrence besides the Upper Cretaceous period also in the Lower Palaeogene sediments is particularly important. The palaeophytographic region, established on the basis of their limited geographical distribution, is referring among others to the European centre of the development of *Angiospermae*. In the spore-pollen assemblage of the sediments from the Lower Tertiary period we need — particularly for determining the geological age — a more comprehensive knowledge of them from morphological, taxonomical and stratigraphic point of view.

Our work is dealing with the species belonging to genera *Basopollis* PF. 1953, *Nudopollis* PF. 1953, *Trudopollis* PF. 1953, *Pompeckjoidaepollenites* (PF. 1953) W. KR. 1967, *Oculopollis* PF. 1953. *Tetrapollis* PF. 1953, and *Stephanoporopollenites* PF. et TH. 1953, from three localities of Palaeocene age (Oiching, Kleinoiching — Austria — and Menat — France). Furthermore, the description of a new genus is also necessary. The pollen grains belonging to genus *Stephanoporopollenites* PF. et TH. 1953 are of outstanding significance from the point of view of sediments of the Palaeocene period. Their literary data are, therefore, summed up separately, as follows.

The first data was published by THIERGART (1940) from the sediments in Hannover of the Palaeocene age, under the name: *Poll. hexaradiatus* n. sp. (Plate XII, Figs. 32, 33). Its stratigraphic importance, i. e. its role as an „index fossil" in determining the geological age, was first referred by POTONIÉ (1935). Its exact description was published in the monograph of THOMSON and PFLUG (1953) (Fgen.: *Stephanoporopollenites* PFLUG et THOMSON 1953; Fgen. type: *Stephanoporopollenites hexaradiatus* (THIERGART) TH. et PF. 1953), by issuing

further localities: Wehmingen — Danian? (Palaeocene; Antweiler — Palaeocene) Lower Eocene. TSCHIGOURIAEVA (1956) published by the name of *Heliotropium anomalum?* (*Pollenites hexaradiatus* THIERG.) a recent valuable data from the Palaeocene sediments from Ukraine. KRUTZSCH (1958) in his work, summing up the most important sporomorphic types of the Upper Cretaceous — Tertiary periods, published several further localities concerning the „Hexaradiatus Gruppe", and later on KRUTZSCH — in KRUTZSCH, PCHALEK and SPIEGLER 1960 — mentioned the occurrence of the genus in the Lower Palaeocene of W. Brandenburg. The Siberian data of KOPITOVA and GRIAZEVA (1960) is important [*Stephanoporo-poll. hexaradiatus* (THIERG.) PFLUG]. It occurred only in one of the four bore-holes mentioned by them — No. 32 — in 1,7 per cent. The modern taxonomical elaboration of the genus was carried out by KRUTZSCH (1961). Further data: in the works of LENK (1961, 1964 — in KUNERT and LENK), KEDVES (1967a, b, 1968a, b) and GRABOWSKA (1968). GÓCZÁN, GROOT, KRUTZSCH and PACLTOVÁ (1967) published new data about the morphology and taxonomy of the pollen grains of *Stephanoporopollenites* PF. et TH. 1953 genus, while revising the *Normapolles* PFLUG 1953 stemma genus. Their stratigraphic importance has been supported by newer, exact data whose essence is as follows:

1) The Palaeocene age is indicated with certainty by the presence of pollen grains in the *Normapolles* province.

2) The Palaeocene age can be clearly divided into zones by the occurrence of some members (form-species, resp. form-subspecies) of their development series.

We have to refer to, as well, that GÓCZÁN, GROOT, KRUTZSCH and PACLTOVÁ (1967) emphasized the necessity of the modern morpho-statistical elaboration of the domain of forms, in hope further results.

Results

Fgen.: *Basopollis* PFLUG 1953

From Lower Tertiary sediments several species are known, the revision of a considerable part of which seems to be reasonable. In order to solve taxonomical problems presenting themselves during our investigations, we need to know the germinal structure of *Basopollis atumescens* (PF. 1953) PF. 1953 and *Basopollis basalis* (TH. et PF. 1953) PF. 1953. On the basis of diagnoses and the published microphotographs, we endeavour to represent them as precisely as possible (Fig. 1).

The genus is represented in our material only in the Thanetian of Menat with two new species to be described below.

N o t e. — As one of the results of our exine ultrastructure investigations of the *Normapolles* species from the Upper Cretaceous and Lower Eocene ages — KEDVES, HEGEDŰS and PÁRDUTZ — we disuse the expressions ectexine and endexine, used so far, in descriptions with the light microscope method. On the basis of the ultrastructural data, the ectexine is of triple proportions (tectum, columellae, foot layer). Endexine — that differs from ectexine in its electron affinity — could not be observed so far in Normapolles from the Lower Eocene

age. The part found by the light microscope to be endexine may be identified with foot layer, lamella „a" of the ectexine with the tectum, and „b" with the columella layer. We endeavour with the help of ultrastructure investigations to elucidate these problems.

1. *Basopollis vancampoae* n. fsp. (Plate I, 1—6; Fig. 1).

Diagnosis

The outer contour has a concave form, the inner contour is approximately triangular. The outer layer of exine is undetachable from the inner one. The extragerminal exine is about 2—2,3 μ thick, the outer layer is much thicker than the inner (V = 3,5—4/1). The outer layer divides into further two parts, the exolamella „b" is of about the same thickness and structure like the inner one, the exolamella „a" considerably thickens in the pore-region. Its thickness is 2,3—3 μ. The pore-canal is 5—8 μ long, its inner two-third part widening out. The pore-canal index, P/d = 0,28—0,41. Owing to the characteristic and several hollows of exolamella „b", there develop several (5—7) small praevestibules being asymmetric in the holotype. There is no vestibule. The inner layer sometimes rises somewhat in V-form in the germinal region.

Maximum size: 20—25 μ.
Holotype: Plate I, 1—3, prep. Menat—34; 22,1/115,9.
Locus typicus: Menat, Palaeocene, Thanetian, zone II.
Stratum typicum: Palaeocene marl.
Derivatio nominis: In honor of Dr. M. VAN CAMPO.
Differential diagnosis: It is well separable from *Basopollis atumescens* (PF. 1953) PF. 1953 by its several tiny praevestibules.

2. *Basopollis guinetii* n. fsp. (Plate I, 7—9; Fig. 1).

Diagnosis

The contour is more or less triangular, with concave sides. The extragerminal exine is 1,9—2,5 μ thick, the outer layer being thicker than the inner one (V = 2—3/1). Exolamella „b" is structured, its thickness being about equal with the inner layer. Exolamella „a" thickens very much in the pore region, the anulus becomes thinner towards the exopore. The pore-canal is 6—9 μ long with numerous (10 or more) tiny praevestibules. Pore-canal index, P/d = 0,32 in average. In optical section, the anulus has a radial structure in interstices more or less corresponding to the praevestibules. The vestibule is developed narrow, crescentformed. The inner layer often rises in the germinal region, with small endopore.

Maximum size: 25—30 μ.
Holotype: Plate I, 7—9, prep. Menat—38; 20,1/113,6.
Locus typicus: Menat, Palaeocene, Thanetian, zone II.
Stratum typicum: Palaeocene marl.
Derivatio nominis: In honor to Dr. PH. GUINET.
Differential diagnosis: It is well separable from *Basopollis basalis* (TH. et PF. 1953) PF. 1953 by the numerous tiny praevestibules and the structure of the anulus.

Fgen.: *Menatipollenites* n. fgen.
Fgen. type: *Menatipollenites triangulus* n. fsp. (Plate I, 10—14; Fig. 2)

Diagnosis

It is a heteropolar, three-germinal pollen with a roughly triangular equatorial contour, on the proximal side with plicae. The germinal openings are split-like, being shorter on the distal side than on the proximal one. The pore-canal index, P/d, is above 0,3.

Locus typicus: Menat, Palaeocene, Thanetian, zone II.

Stratum typicum: Palaeocene marl.

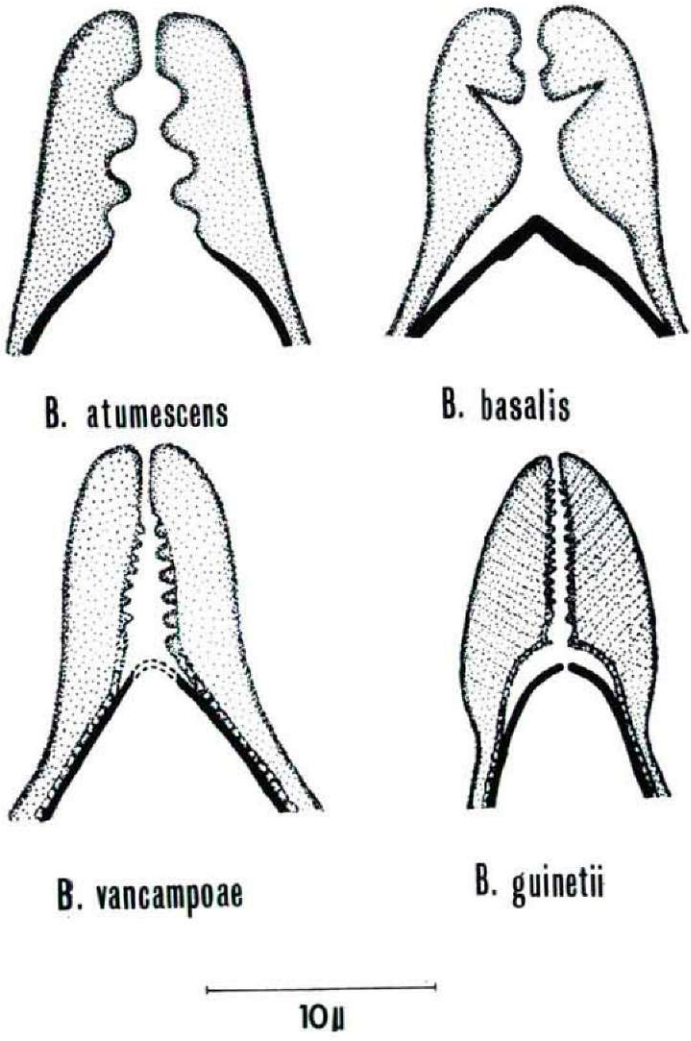

Fig. 1. Pore wall region of some *Basopollis* species in optical section .

Derivatio nominis: From Menat, the locality of type.

Differential diagnosis: It is similar to *Lusatipollis* W. KR. et PACLT. 1967 but with a different exogerminal, „äquatorialen Exogerminalien, die oculusartig verstärkt".

Menatipollenites triangulus n. fsp.

Diagnosis

The equatorial contour is triangular, sometimes with somewhat convex lateral lines. The extragerminal exine is thin, 0,8—1,2 μ, the outer and inner walls are roughly equal in thickness (V = 1/1). The anulus is nearly triangular, on the bottom 3—5 μ wide. In about the width of the base of anulus, in the inner layer, there are four-five characteristic, centripetal thickenings and at the endoporus a small endanulus. The pore canal is 7—9 μ long, the pore-canal index, P/d is about 0,34. On the proximal side, the length of the split-like exogerminal corresponds to that of pore-canal, on the distal side it is, however, shorter (about 5 μ). The proximal surface is smooth or punctuated, the distal side is rarely granulated. The plicae of the proximal surface connect the bases of anuli and are bent towards the pole.

Maximum size: 20—25 μ.

Holotype, locus typicus, stratum typicum: cf. above.

Derivatio nominis: From its characteristic contour.

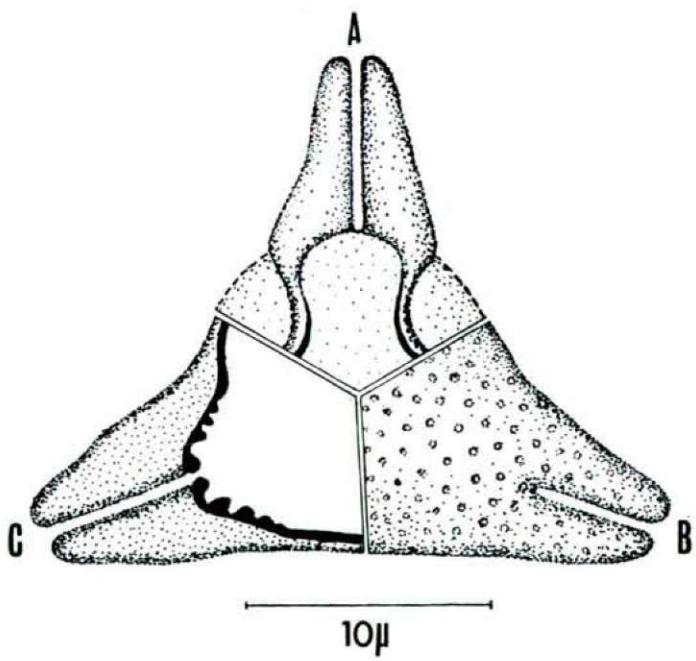

Fig. 2. *Menatipollenites triangulus* n. fgen. et fsp.; A: Proximal surface, B: Distal surface, C: Optical section.

Fgen.: *Nudopollis* PFLUG 1953

It is a frequent genus not only in the sediments of Palaeocene but also in those of Lower Eocene. Among the species described so far we could observe several transitions, as well.

1. *N. endangulatus* (PF. 1953) PF. 1953 (Plate I, 15—17). It is frequent in all the three localities investigated. Particularly in the material from Menat there occurred in large number exemplars with plicae, too. Also the occurrence of transitional specimens between this species and N. terminalis (TH. et PF. 1953) PF. 1953 is general; they are frequent first of all in the Thanetian at Menat (Plate I, 18—20).

2. *N. thiergarti* (TH. et PF. 1953) PF. 1953. Its typical specimens occurred in the sediments Monsian at Oiching, and in the deeper sediments of Thanetian stage at Kleinoiching (Plate II, 1—3). The so-called „younger" forms of thin wall (Plate II, 4, 5) are frequent in the layers of Menat. This latter is also showing a transition in some degree towards *N. terminalis* (TH. et PF. 1953) PF. 1953.

3. *N. terminalis* (TH. et PF. 1953) PF. 1953 (Plate II, 6—8). It is frequent in the Thanetian at Menat, and even in older sediments. The specimens observed belong to the hastaformis subfsp., a typical representative of the form-species.

The temporary name cf. *Nudopollis* fsp. is denoting a pollen form, so far found in a few exemplars only at Menat (Plate II, 9, 10). It is quite likely that they belong to a new taxon. However, we need further data to elucidate that problem.

Fgen.: *Trudopollis* PFLUG 1953

1. *T. nonperfectus* (PF. 1953) PF. 1953 (Plate II, 11, 12). It occurred but sporadically in our samples.

2. *T. subperfectus* (PF. 1953) PF. 1953 (Plate III, 1, 2, cf. 8—10). We have found them in the sediments Monsian at Oiching and in the deeper sediments of Thanetian stage at Kleinoiching. In the latter locality it occurs frequently.

3. *T. orthomechanicus* PF. 1953 (Plate III, 3—5). Its locality of occurrence is identical with the former one but rarer.

4. *T. varioreticulatus* (STELMAK 1960) ZAKLINSKAIA 1963 (Plate II, 13—15). It is sporadic in all the three localities. It occurred with specimens in very good preservation in the material of Menat.

5. *T. hemiperfectus* (PF. 1953) PF. 1953 (Plate III, 6, 7). It occurred first of all in the deeper part of the Thanetian (Kleinoiching) but sporadically it was also found in the Monsian (Oiching).

Fgen.: *Pompeckjoidaepollenites* (PFLUG 1953) emend. W. KR. 1967

It is a genus only little elaborated in its details. From the genus *P. subhercynicus* (W. KR. 1954) W. KR. 1967 we can observe several transitional forms towards many further types. Comparing our data with previous results (KEDVES, 1967a) it seems that the size of these pollen-grains in the Lower

and Middle Eocene decreased in opposite to those from the Palaeocene age. In the course of the present investigations we could observe the typical *P. subhercynicus* (Plate III, 14—16) in the sediments of Thanetian stage, and in the deeper parts of the Monsian and Thanetian its forms of large size that form a transition a little towards *P. absurdus* (WEY. et KRIEG. 1953) W. KR. 1967. In the Kleinoiching layers we have found also the specimens of *P. subhercynicus* with a strongly granulated surface (Plate III, 17—19), which can later be described as a subspecific form. From Menat *P. peneperfectus* (PF. 1953) W. KR. 1967 (Plate III, 11—12) was found, connected with *P. subhercynicus* also by essentially transitional forms.

Fgen.: *Oculopollis* PFLUG 1953

During our investigations, this genus was found only in localities at Oiching (Monsian). We publish here one of its specimens in good condition. — *O.* cf. *fastidicus* WEYL. et KRIEG. 1953 (Plate III, 20—22).

Fgen.: *Tetrapollis* PFLUG 1953

The two species — *T. validus* (PF. 1953) PF. 1953 (Plate IV, 1—3), *T. polyangulus* (PF. 1953) W. KR. 1967 (Plate IV, 4, 5) — occurred in localities at Oiching and Kleinoiching.

Fgen.: *Stephanoporopollenites* PF. et TH. 1953

1/a. *St. hexaradiatus* (THG. 1940) TH. et PF. 1953 subfsp. *hexaradiatus* (Plate IV, 6—8).

1/b. *St. hexaradiatus* (THG. 1940) TH. et PF. 1953 subfsp. *semitribinae* W. KR. 1961 (Plate IV, 12—14).

1/c. *St. hexaradiatus* (THG. 1940) TH. et PF. 1953 subfsp. *tribinae* W. KR. 1961 (Plate IV, 18—20).

2. *St. pentaradiatus* W. KR. 1961 (Plate IV, 21—23).

We have observed several transitional forms among the subspecies of *St. hexaradiatus* (THG. 1940) TH. et PF. 1953:

hexaradiatus/semitribinae (Plate IV, 9—11)
semitribinae/tribinae (Plate IV, 15—17).

The stratigraphic occurrence (that is according to localities) of the forms observed is as follows (Fig. 3):

The typical forms of *St. hexaradiatus hexaradiatus* occurred only in the Lower Palaeocene — Monsian — sediments of Oiching. In addition, we have found several transitional forms resembling semitribinae, a part of which differ only to a slight degree from the practically symmetrical forms. In the Lower Thanetian sediments of Kleinoiching we have found only the transitional forms mentioned above, with the difference that the triple symmetry of the forms that are transitional towards the semitribinae is more expressed than in the former layers. In the Thanetian of Menat (zone II) only semitribinae and tribinae subfsp. occurred, with a great many transitional types.

St. pentaradiatus W. KR. 1961 cannot be included in this series. As referred to by KRUTZSCH (1961), it might be that it is not an independent form-species but an abnormal form of *St. hexaradiatus*.

Discussion

The *Normapolles* taxa treated in our work may be classified from phylogenetic and stratigraphic points of view. In the Lower Eocene sediments of the Paris basin pollen-types representing four degrees of development could be separated (KEDVES, 1968a). Taking that into consideration:

1. The *Normapolles* originating from the Upper Cretaceous period are the following in our material:

Oculopollis cf. *fastidicus*
Pompeckjoidaepollenites absurdus
Trudopollis orthomechanicus
Trudopollis hemiperfectus
Trudopollis nonperfectus
Trudopollis subperfectus.

2. We consider *Tetrapollis* validus and *Tetrapollis polyangulus,* as well as *Stephanoporopollenites hexaradiatus* and *Stephanoporopollenites pentaradiatus* as Palaeocene of stratigraphic distribution. On the above basis, *Trudopollis varioreticulatus* is a species marking the Palaeocene or Lower Eocene period, although in this respect we are still in need of further verifying data.

Characteristic forms of the Palaeocene and Lower Eocene sediments are: *Basopollis basalis,*

Basopollis atumescens. Our newly described species may belong to this group *(Basopollis vancampoae, Basopollis guinetii)* and also *Menatipollenites triangulus,* owing to their basic morphology.

The stratigraphic value of the discussed *Nudopollis* species is roughly similar, as well, although from them *Nudopollis terminalis* can occur in the layers of the Middle Eocene age, too. *Nudopollis endangulatus* and *Nudopollis thiergarti* contain an extremely high number of transitional types, first of all in the direction of *Nudopollis terminalis.* Thus *Nudopollis terminalis* may be considered „younger" than the two species mentioned above. From a taxonomic point of view, nevertheless the species of *Nudopollis* owing to the high number of their transitional forms, may be a subjectmatter of further investigations. In connection with them, we have again to refer to the question of the limits of form-species and the variation within the form-species. This problem seems to be particularly significant in taxa in formation during the initial phase of their development and it also gains importance in the case of other types too.

Summary

The paper discusses species belonging to the genera *Basopollis* PF. 1953, *Nudopollis* PF. 1953, *Trudopollis* PF. 1953, *Pompeckjoidaepollenites* (PF. 1953) W. KR. 1967, *Oculopollis* PF. 1953, *Tetrapollis* PF. 1953 and *Stephanoporopollenites* PF. et TH. 1953 from three Palaeocene localities (Oiching, Kleinoiching and Menat). The description of two new species *(Basopollis vancampoae, Basopollis guinetii)* and a new genus are given *(Menatipollenites).* The taxe represent several degrees of the evolutionary history of pollens.

M O N S I A N T H A M E T I A N

Z.I. Z.II.

T R I B I N A E

Plate I

1—3. — *Basopollis vancampoae* n. fsp., prep. Menat—34; 22,1/115,9.
4—6. — *Basopollis vancampoae* n. fsp., prep. Menat—34; 21,5/108,6
7—9. — *Basopollis guinetii* n. fsp., prep. Menat—38; 20,1/113,6.
10—14. — *Menatipollenites triangulus* n. fgen. et fsp., prep. Menat—39; 15,8/119,3.
15—17. — *Nudopollis endangulatus* (Pf. 1953) Pf. 1953, prep. Menat—25; 20,7/113,6.
18—20. — *Nudopollis endangulatus* terminalis, prep. Menat—31; 20,2/102,8.

Plate II

1—3. — *Nudopollis thiergarti* (Th. et Pf. 1953) Pf. 1953, prep. DI/2—28; 20,5/117,9.
4,5. — *Nudopollis thiergarti* (Th. et Pf. 1953) Pf. 1953, prep. Menat—34; 13,2/106,9.
6—8. — *Nudopollis terminalis* (Th. et Pf. 1953) Pf. 1953, prep. Menat—21; 11,2/110,2.
9,10. — *Cf. Nudopollis* fsp., prep. Menat—39; 12,2/102,8.
11,12. — *Trudopollis nonperfectus* (Pf. 1953) Pf. 1953, prep. Menat—38; 6,4/107,9.
13—15. — *Trudopollis varioreticulatus* (Stelmak 1960) Zaklinskaia 1963, prep. Menat—31; 5/115,9.

Plate III

1,2. — *Trudopollis subperfectus* (Pf. 1953) Pf. 1953, prep. DI/2—26; 4,2/107,9.
3—5. — *Trudopollis orthomechanicus* Pf. 1953, prep. DI/2—25; 12,4/119,2.
6,7. — *Trudopollis hemiperfectus* (Pf. 1953) Pf. 1953, prep. DI/2—16; 12,7/109,8.
8—10. — *Cf. Trudopollis subperfectus* (Pf. 1953) Pf. 1953, prep. DI/2—36; 4,2/114,3.
11—13. — *Pompecjoidaepollenites peneperfectus* (Pf. 1953) W. Kr. 1967, prep. Menat—44; 20,6/105,8.
14—16. — *Pompeckjoidaepollenites subhercynicus* (W. Kr. 1954) W. Kr. 1967, prep. DI/2—21; 20,6/105,8.
17—19. — *Pompeckjoidaepollenites subherynicus* (W. Kr. 1954) W. Kr. 1967, prep. DI/2—28; 22/115,6.
20—22. — *Oculopollis* cf. *fastidicus* Weyl. et Krieg. 1953, prep. DI/1b—22; 4,6/116,4.

Plate IV

12—14. — *Stephanoporopollenites hexaradiatus* (Thg. 1940) Th. et Pf. 1953 subfsp. *semitribinae* W. Kr. 1961, prep. Menat—36; 9,3/109,2.
15—17. — *Stephanoporopollenites hexaradiatus* (Thg. 1940) Th. et Pf. 1953 subfsp. *semitribinae/tribinae* W. Kr. 1961, prep. Menat—39; 17,6/117,3.
18—20. — *Stephanoporopollenites hexaradiatus* (Thg. 1940) Th. et Pf. 1953 subfsp. *tribinae* W. Kr. 1961, prep. Menat—37; 15,4/115,7.
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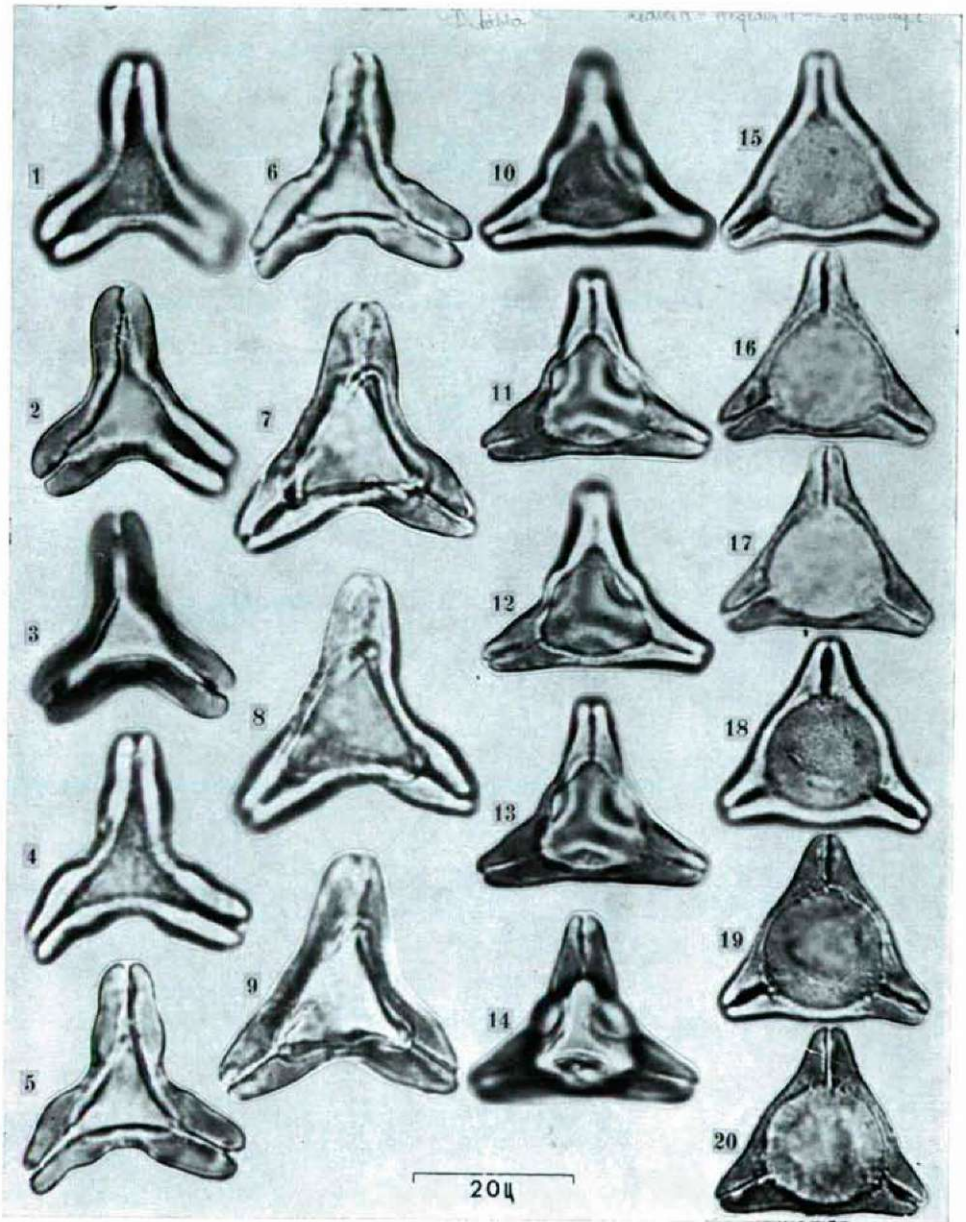
1—3. — *Tetrapollis validus* (Pf. 1953) Pf. 1953, prep. DI/2—29; 5,1/111,8.
4,5. — *Tetrapollis polyangulus* (Pf. 1953) W. Kr. 1967, prep. DI/2—28; 6,1/114,2.
6—8. — *Stephanoporopollenites hexaradiatus* (Thg. 1940) Th. et Pf. 1953 subfsp. *hexaradiatus*, prep. DI/1b—34; 8,4/113,7.
9—11. — *Stephanoporopollenites hexaradiatus* (Thg. 1940) Th. et Pf. subfsp. *hexaradiatus/semitribinae* W. Kr. 1961, prep. DI/1b—33; 17,6/106,8.

Plate I



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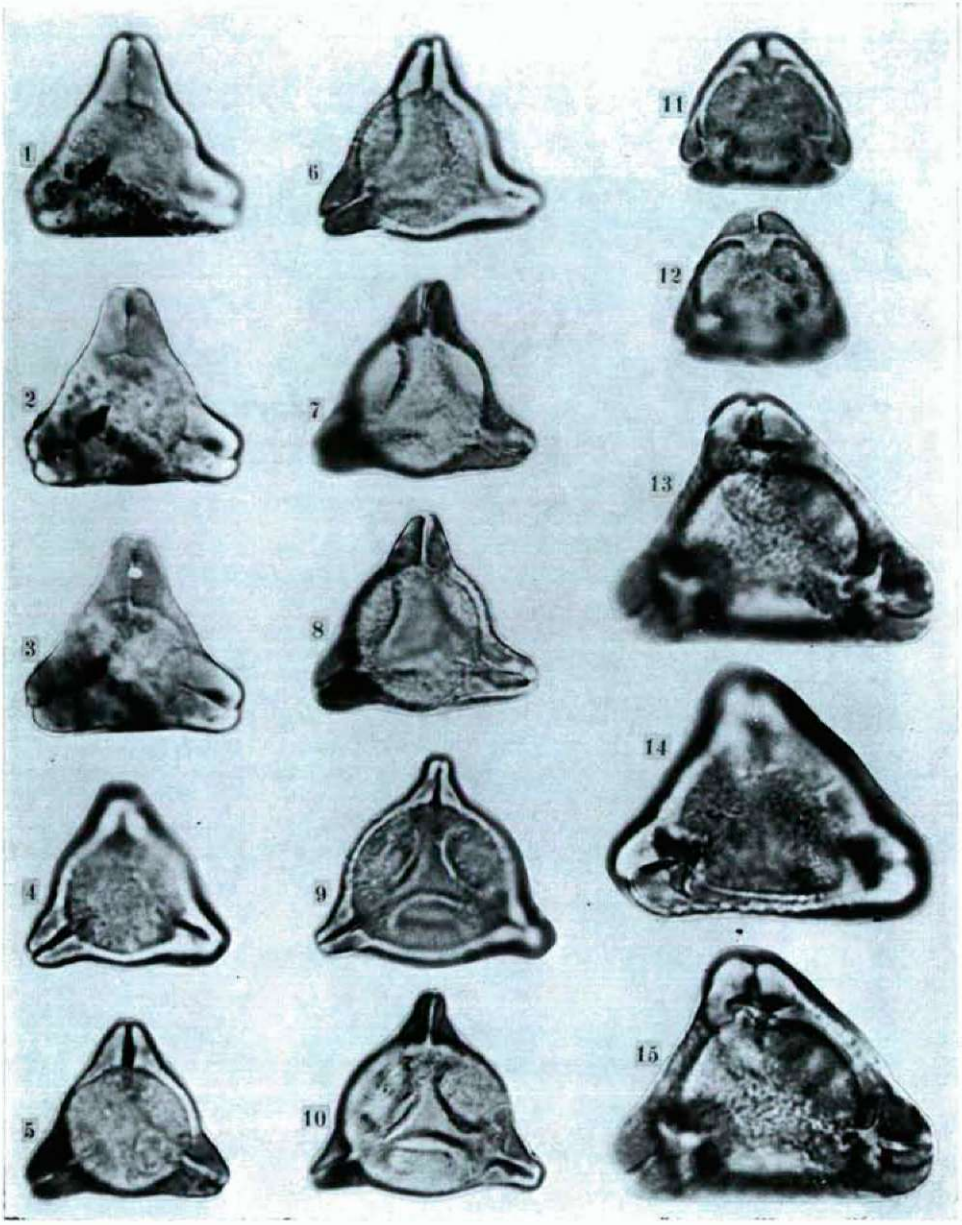

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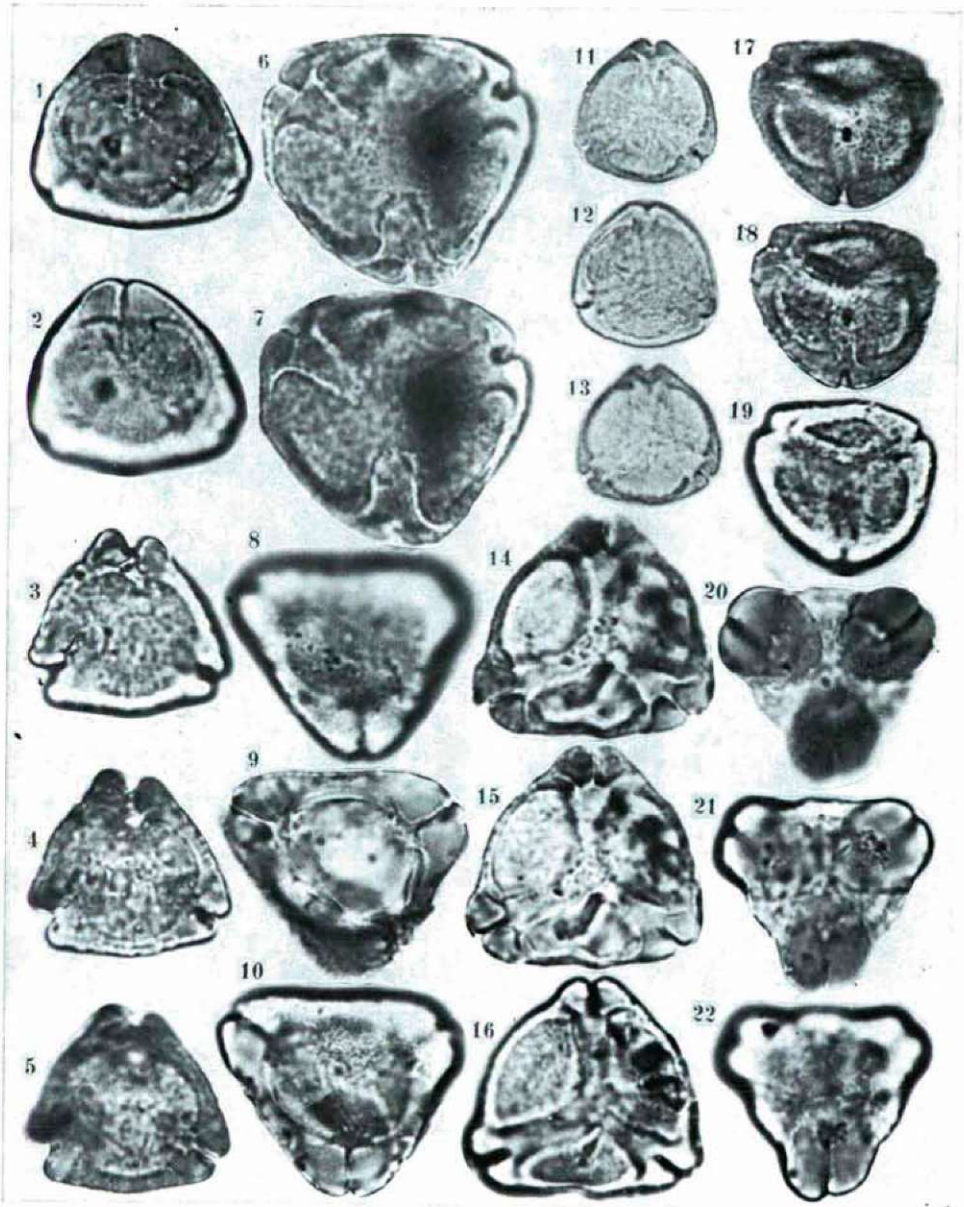

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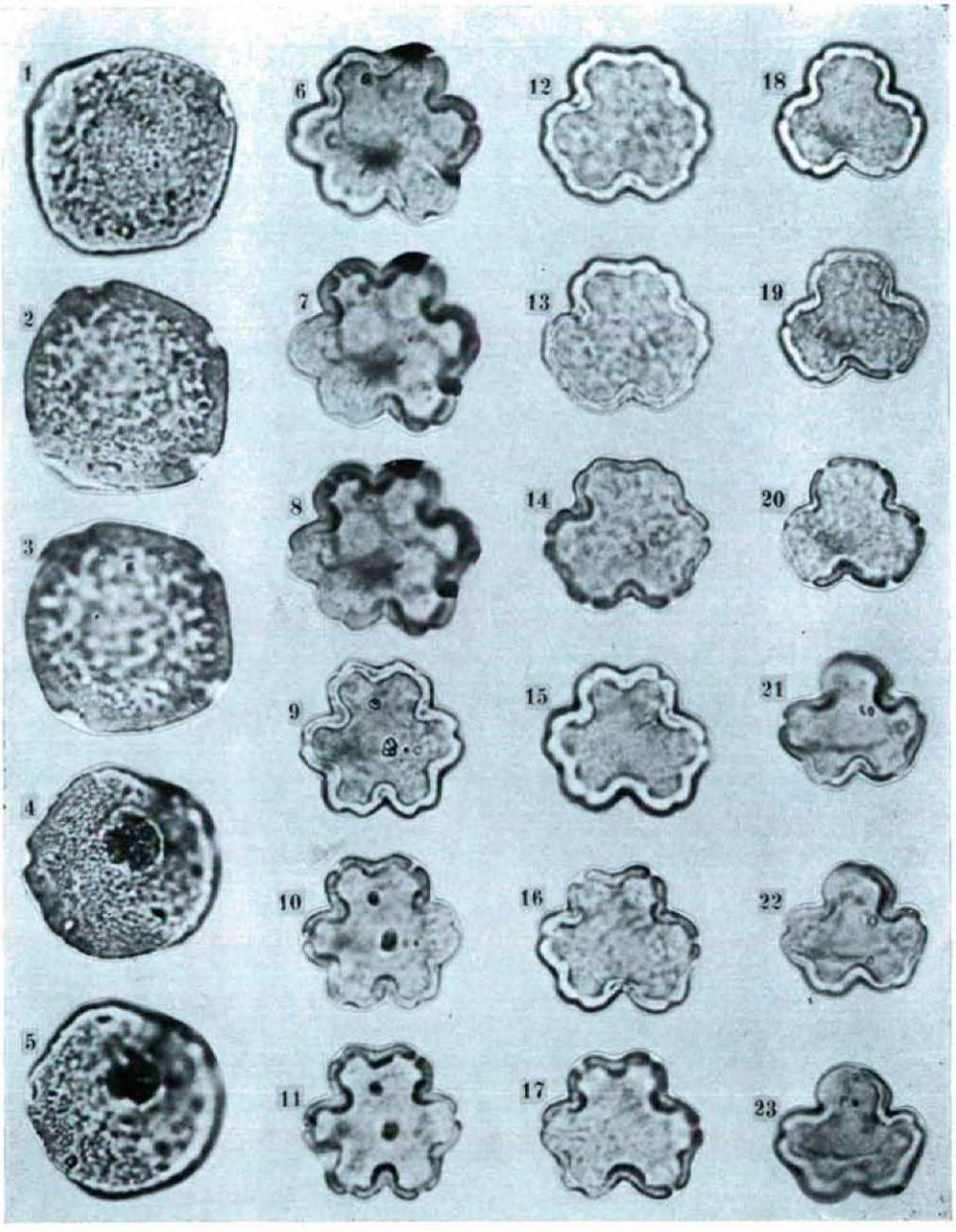

Acta Biologica Szeged 17 (1—4), pp. 63—65 (1971)

ULTRASTRUCTURE INVESTIGATIONS ON THE EXINE OF THE GENUS CASUARINA L.
(SHORT COMMUNICATION)

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(Received September 28, 1970)

The light-microscopic morphology of the pollen grains of the genus *Casuarina* is similar to that of *Betula, Myricaceae, Corylaceae,* and some *Juglandaceae* types (ERDTMAN 1952, COOKSON and PIKE 1954, PRAGLOWSKI 1962, KUPRIANOVA 1965). However, UENO (1963) has obtained different results, in contradiction with the earlier findings in applying TEM and light-microscopic papilla-reaction methods. On the basis of his description, the *Casuarina* exine ultrastructure considerably differs not only from the *Amentiflorae* taxons mentioned but also from the rather general basic ultrastructure of *Dicotyledones* (tectum, columellae, foot layer). According to our TEM investigations carried out on the exine of *Casuarina glauca* SIEB. and *Casuarina cumminghamiana* MIQ., we have ascertained that the exine is tectate and, therefore, fundamentally of Dicotyledonous type. It can be separated, however, by its columella layer from the *Myrica* pollen that is light microscopically very similar to it. The surface and the columella layer are the most similar to the genus *Betula* and *Carpinus*. By means of ultrastructure investigations it is possible to demonstrate the genus *Casuarina* among the fossil „myricoid" pollen grains.

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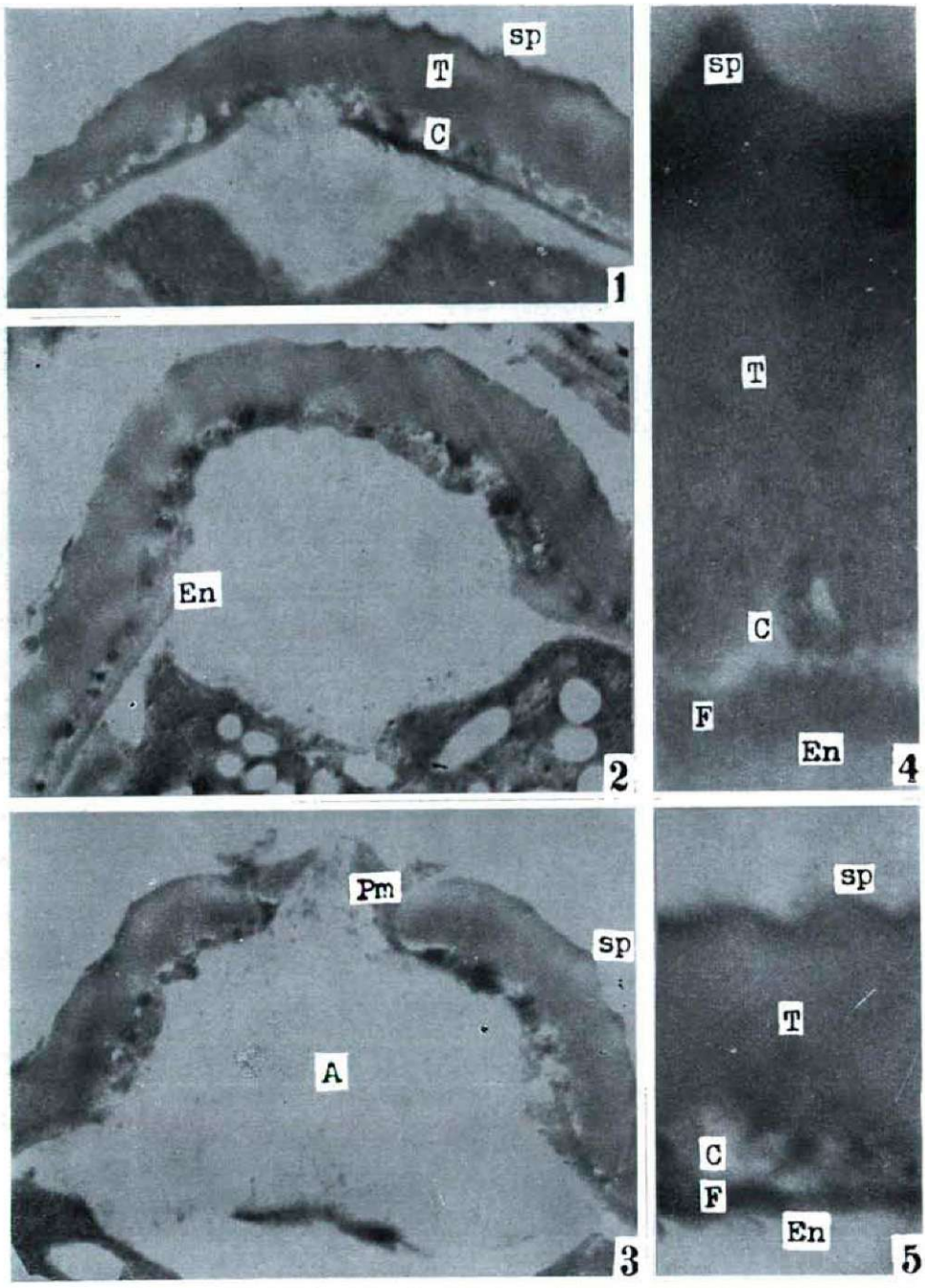

sp = spinae, T = tectum, C = columellae, F = foot layer, En = endexine, Pm = pore membrane, P = pore, A = atrium.

1—3. Germinal exine of *Casuarina cunninghamiana* MIQ. in serial sections x10 000. The foot layer and endexine break off on the basis or in the first one-third of the prominent germinal exine (Figs. 2, 3); in that way, there is atrium without anulus.
4. *Casuarina glauca* SIEB. x100 000.
5. *Casuarina cunninghamiana* MIQ. x25 000. Extragerminal exine. Tectate non perforate, the surface with spinae, taking place on ridges. The columella layer is narrow, with elements of varied shapes. The foot layer is narrower even than the former layer, with an endexine of but a little different electron affinity situated underneath.

Acta Biologica Szeged 17 (1—4), pp. 67—77 (1971)

SEPARATION OF CHLOROPHYLLS AND CAROTINOIDS BY THIN-LAYER CHROMATOGRAPHY

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(Recived July 20, 1971)

Introduction

Owing to its well-known advantages, — thin-layer chromatography (TLC) has become a prevailing method for separating the chemical components originating from the inanimate nature and the living organisms. This up-todate branch of separation technique has so far not shown entirely its favourable properties in the field of vegetable pigments. As a result of the chemical nature of pigments, several problems are to be solved in the course of preparative separation. It seems necessary to elaborate some methods with which the extraction of pigments and the separation of the single components do not take more than about fourty minutes altogether.

For the quantitative determination revealing the ratio of the single components, it is desirable that in the course of a single wash the chlorophylls, carotenes, and xantophylls should be clearly separata from one another on one and the same sheet, and suffer but a minimum decomposition and transformation. In case of serial measurings, indispensable for the investigations, of metabolism and plant improvement, it is rather essential to obtain reliable measuring values even from a small quantity of material (0,2—2 g gross weight).

Trying to achieve a maximum degree of precision, a fast process like this, can not be expected but from a method that goes without washing, filtering, drying, etc. These requirements preclude, as a matter of course, the possibility of column- and paper-chromatographies.

We have compared the methods dealing with the thin-layer chromatographic investigation of pigments, as described in literature, and have found that no uniform method of comparable advantages has been elaborated as yet for the separation of other matters. The composition of layers is mostly complicated, the extraction and separation demand special conditions making the execution circumstantial and slow.

Taking into consideration the labile chemical nature of the colouring agents, we have elaborated a process permitting to separate and identify quite simply more components simultaneously — carotenes, xantophylls, and chlorophylls. The clear-cut separation makes possible quantitative identification in addition to the qualitative identification of the single pigments.

Materials and Methods

1. The material investigated

We have endeavoured to test our separation technique on the leaves of species of as many different taxons as possible. When applying other methods described in literature — HAGER (1962, 1966), EGGER (1962) — we have noticed that the succesful separation of pigments depends upon the plant object investigated, as well. Leaf pigments have been separated at the following plants: *Solanum laciniatum* AIT., *Solanum dulcamara* L., *Verbascum phlomoides* L., *Spinacia oleracea* L., *Triticum aestivum* L., *Oryza sativa* L.

Our micromethod is first of all suitable for the investigation of ecological effects and metabolism. (For column-chromatographic separations one generally starts from 40—100 g raw material [Müller, 1964].)

1.1 Sampling

For making extracts we have used 0,05—1 g fresh leaf. Four parallel measurements were made from every sample. Because of the little material, sampling was made most carefully. Leaves of the same degree of development and of the same position were compared, since pigment content depends largely on the position and age of leaves. The main rib of leaf, and the leaf-stalk was not measured in the sample. For the pigment extraction we have taken disks of 0,5—1 cm ∅ from one half of the leaf, while the other half of the leaf was used for determining the dry matter.

1.2 Pre treatment of the fresh leaf materials

For denaturating the protein colouring agent complexes, the leaf material is dipped by several investigators into hot water before extraction. Leaves were kept by KOSKI and SMITH (1948) in a water of 90 °C for five minutes, by KALER and SHLYK (1962) for two minutes. HAGER—MEYER—BERTENRATH (1966) deem it necessary to inactivate the enzymes only in case of young leaves, suggesting to dip them into hot water for one minute. High temperature, however, induces the decomposition of chlorophylls into pheophytins and causes the transformation of carotinoids so we made no pre treatment. The material collected was processed in a short time or stored in a dark place (refrigerator) at +4 °C for 1—2 hours.

2. Extraction of pigments

2.1 Choice of solving material

With a view to extractability of the single pigments, the choice of the extracting solving materials and the way of extraction is very important. Number of research workers use alcohol — first of all in case of algae. STEEMAN—NIELSEN (1961) prefers methanol to acetone for extracting Chlorella pigments. COHEN—BAZIRE (1957) used an acetone-methanol mixture (7 : 2) for extracting the bacteriochlorophyll. STRAIN (1958) achieved the minimum decomposition of pigments by an absolute methanol — petroleum ether combination (2 : 1). For extracting chlorophyll from leaf tissue, WICKLIFF and ARONOFF (1962) prefer an 80 p. c. cooled ethanol. We found that in case of higher plants wet alcohols are not suitable for extraction since chlorophyllase has a strong effect within them, causing the decomposition and transformation of chlorophyll. According to STRAIN (1958), in 6—24 hours, methyl-chlorophyllids a and b come into being in the methanolic extraction of the fresh leaf. We have also

observed that, the pigments, first of all chlorophylls, suffer considerable enzymatic, autooxidative, and isomerizational changes in alcoholic extract. Petrol, benzene, petroleum ether cannot be used for extraction, as owing to them the fission of the protein pigment complexes is slight, and, as a consequence, the full dissolution of pigments, first of all of chlorophylls and xantophylls, does not succeed. The extracts containing water are light-sensitive in a higher degree, the colouring agents they contain are fading soon or, in the presence of oxygen, allomerized chlorophylls are produced.

In the research of plant pigments, 80 per cent acetone as a primary extracting medium is widely spread and, in the opinion of most investigators, it is actually the most efficient dissolvent. Chloroform Free from hydrochloric-acid was used — by HAGER—MEYER—BERTENRATH (1966), MÜLLER (1964), and others — this is, however, not a current method.

When the purpose of the pigment investigation is only a quantitative determination of carotinoids, many researchers apply other methods and dissolvents. The extraction of carotinoid stains from ensiled and dried vegetable matters was carried out by Mrs. RÉTALJI and Mrs. JAKABFI (1969) with ethanol or a combination of ethanol-ether-acetone at a ratio 1 : 1 : 1. For extracting the carotene content of fresh green plants and hays, WALGER and MRS. THURÁNSZKY (1962, 1965) used a combination of petrol-petroleum ether at a 2 : 1 ratio.

Even in connection with the acetonic extraction, that proved to be the most practicable for extracting the total pigment, some difficulties arise:

a) An acetonic extract cannot be decanted safely because the pulverized cell particles remain in suspension. Therefore some of the researchers — HAGER—MEYER—BERTENRATH (1966), IHÁSZ (1960) — filtrate it through a glass filter or filter paper and others — MÜLLER (1964) — centrifuge it, but this, of course, requires more time for preparative work, and involves also some loss in material.

b) By acetone the materials of proteic and lipoid character are also dissolved, — particularly from young cells — and at a following chromatography they cause a „sticking" at the starting point and a blurred, smudged separation of the pigments. On the other hand, the pigments in acetonic phase can generally not be separated by adsorption chromatography since adsorption is highly impeded by acetone. Therefore, the most investigators: WORKER (1957), IHÁSZ (1966), BOOTH (1967), SHERMA (1967), and others take over the pigments from the acetonic solution into a petroleum ether phase, or endeavour to achieve a full acetone-freedom by watery-methanolic washing.

2.2 The total pigment extraction applied

Contrary to the methods described so far in literature, the process suggested by us tries to utilize the favourable properties of acetone and petroleum ether together and jointly as well as successively.

The samples were put in a china mortar of 5 cm diameter, adding to them some quartz sand and a few miligrammes of $MgCO_3$. According to our experience, $MgCO_3$ is more suitable for neutralizing plant acids than $CaCO_3$, or the hydroquinine suggested by BOOTH (1967), is. With $MgCO_3$ the pH value 7,1—7,2 can easily be obtained.

We extract the 0,5 g fresh leaf material with 2 ml 100 p. c. cooled acetone and about 10 ml petroleum ether (of 80 °C boiling-point) in the following way:

a) We add to the 0,5 g material weighed in previously cooled friction mortars about 1 ml cooled acetone and smear it thoroughly for about one minute.

b) Then, we add about 2 ml petroleum ether and homogenize it entirely in one minute or two.

c) The homogenized material is given a rub („washing") with about one ml petroleum ether, after being carefully ground, and the dark green pigment solution (cca. 1 ml) is decanted into a graduated measuring eprouvette.

d) Then the precipitate in the mortar is rinsed through several times (four-five times) in a way that first we rub it over with a few drops of acetone, dissolving the residual pigment from the side of the rubbing mortar, and decant it after rinsing through with one ml petroleum ether. We set the pigment extract in this way to 5 ml.

According to our comparative investigations, in this way there may remain much less pigment in the homogenized leaf material than the loss of pigment decomposed or transformed during filtration, centrifuging, washing, and drying.

The pigment extract obtained in that way contains nearly in full quantity and almost unchanged the carotenes, xantophylls, and chlorophylls. It can be directly used for chromatographic separation. The extract may be preserved — practically without any decomposition — in a dark place and at $\pm 4°C$ for days.

For deciding, how the quantity of chlorophyll and β-carotene is influenced by light during pigment extraction, we have carried out parallel extractions in dark (with green lamp) and in light, and have investigated the extracting peculiarities of acetone and petroleum ether both cooled and of room-temperature.

3. Preparation of thin-layer sheets

Thin-layers of different composition are used for separating pigments. We have compared the separation techniques described in literature: HAGER-BERTENRATH (1962), HAGER-MEYER-BERTENRATH (1966), EGGER (1962), MÜLLER (1964), RANDERATH (1962), SHERMA-ZWEIG (1967), and we have found two as the best ones. HAGER-BERTENRATH (1962), HAGER-MEYER-BERTENRATH (1966) use a method based on the distributive thin-layer chromatography, for separating chlorophylls and carotinoids. The composition of their layer is:

12 g Kieselgur G (Merck 8129)
3 g Kieselgel „umder 0,08 mm" (Merck 7729)
3 g $CaCo_3$ (Merck 2066)
0,02 g $Ca(OH)_2$ (Merck 2047)
50 ml aqueous ascorbic-acid solution, 8×10^{-3} m.

The layer is made with a mixing apparatus, to be 0,125 mm thick. The wash liquid is: 100 ml petrol (Kp 100—140), 12 ml isopropanol and 0,25 ml distilled water.

The other sheet-making technique found to be satisfactory is EGGER's method (1962): mixing 10 g Kieselgur G (Merck) and 1 g gypsum with 15 ml dioxane into a soft pulp and diluting it with 10 ml water. He makes the layer to be 200—300 μ thick, drying the leaves for several hours at 80—100 °C and then impregnating them with the 7 p. c. petroleum ether solution of subacidic plant oil. He interrupts the impregnation is interrupted when the front approa-

ches the edge of the sheet to 3—4 cm. Then he lets it dry on 70 °C for about one hour, and applies the pigment mixture to the non-impregnated part. The development takes place in the dark, with the combination of methanol-acetone-water at a ratio of 20 : 4 : 3.

The isomerous carotinoids (e. g., α- and β-carotenes or lutein and zeaxanthin) also get separated on the impregnated sheets. A disadvantage of impregnation is the necessity of removing the impregnating material before spectrophotometric determination or else the spectrum would be influenced thereby.

For making the layer, we have used the mixture of Cellulose powder MN 300 and Silica gel G to Stahl. We have mixed 20 g Silica gel and 10 g Cellulose powder with 100 ml distilled water (with an electric mixer) to a homogeneous pulp in one minute. 8 ml of the pulp was put with a pipette on a 18×5 cm degreased and dried glass plate. The smearing was performed by means of a glass rod. The thickness of the layer was 200—300 μ. The 20×20 cm plates were prepared with a smearing apparatus. The plates were left to desiccate on a horizonal and dust-free place for eight hours, and then activated at 120 °C. After being cooled they can be immediately used. It is the best to store the ready plates in exsiccators.

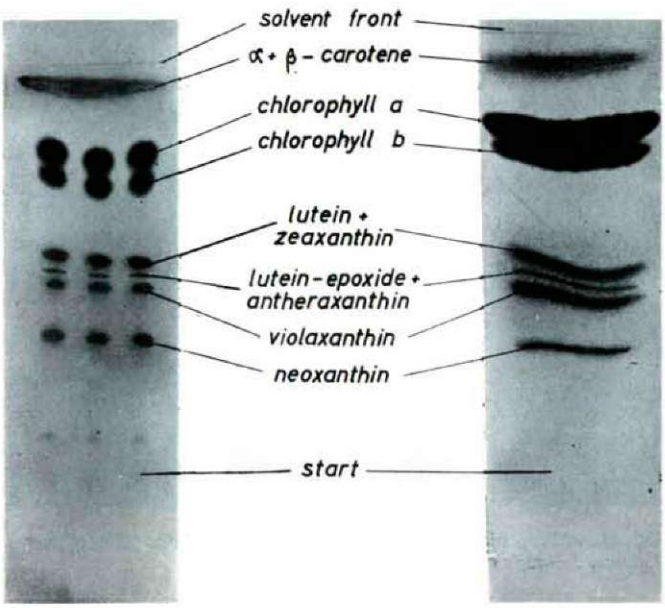

Fig. 1. Photograph of thin layer chromatogram of plastid pigments from *Verbascum phlomoides* L.

The cellulose is of neutral reaction, it does not isomerize the xantophylls like the aluminium-oxide, magnesium-oxide or silicaceous adsorbents. It has the further advantage of better mechanical adhesiveness and stronger resistance to fracture, but it cracks when peeled off. Its disadvantage consists in poor adsorption, therefore the carotinoids do not separate well.

The pure Silica gel is of slightly acidic reaction — Szász (1964) — to it isomerizes the pigments or transforms chlorophylls into pheophytin. It is one of its major advantages that it separates the single components.

The mixture system Silica gel-cellulose powder at a ratio of 2 : 1, used by us, combines the advantages listed above without the disadvantages.

4. Application of the pigment extract

The petroleum ether pigment extract was applied to the thin-layer with a micropipette small quantities of the material should better be applied on stains of 6—8 mm diameter, major quantitio, however, on a line. The starting point is 3 cm from the edge of the plate. Owing to the quick evaporation of the petroleum ether, the material can be applied to two plates without interruption. For developing the chromatogram the stains must not be desiccated.

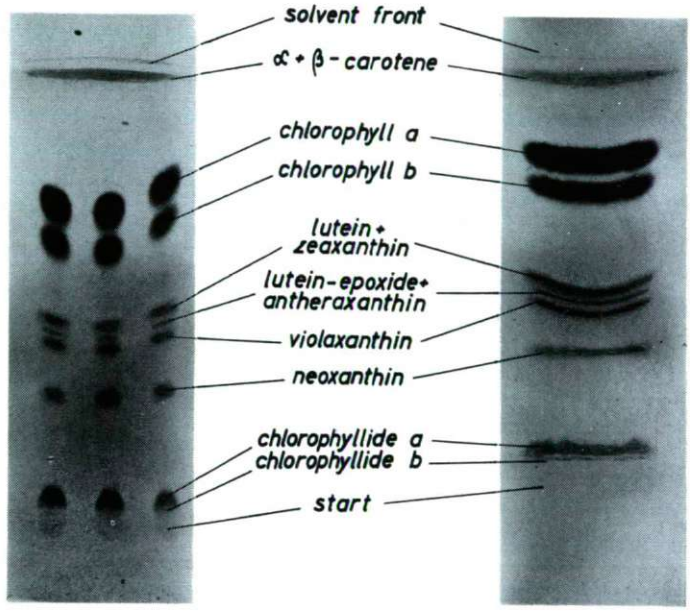

Fig. 2. Distribution of various pigments on the plate cromatoplate. The pigments are from the leaf of *Solanum laciniatum* Ait., kept in darkness.

5. Development of the chromatogram

The development takes place in a refrigerator, in the dark, with the following combination: benzene-petroleum ether-absolute alcohol-water, at a ratio of 5 : 5 : 1 : 0,5. We have applied a one-dimensional ascendant method. The distance of development is 10—14 cm. The wash-time is about 30 minutes, in case of 5×18 cm plates, 45 minutes for 20×20 cm plate size.

6. Elution of colouring agents

For spectrophotometric investigations the colouring agent zones are to be peeled off when still wet, as the epoxidic carotinoids suffer a quick change. A blade will be the most suitable for peeling purposes. The single colouring agents were eluted in ethanol and then centrifuged.

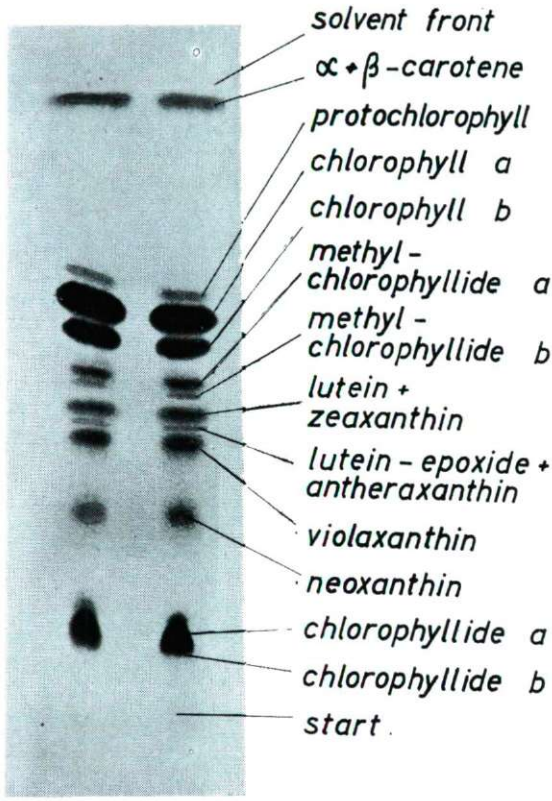

Fig. 3. Thin layer chromatographic (TLC) extraction of plastid pigments extracted by Methanol–aceton (1 : 10). The pigments are from the young leaf of *Oryza sativa* L., kept in darkness.

Results and discussion

1. Succession of the separation of pigments

On the plate the three groups of colouring agents — carotenes, xantophylls, and chlorophylls — are distinctly separated. They can easily be recognized by their colour, their reciprocal site and their Rf-value (Fig. 1).

In case of a cellulose — Silica gel system, the chlorophylls are localized on the plate between carotenes and xantophylls. In an impregnated layer, ho-

wever — MÜLLER (1964) — they take place among the xantophylls. The sequence of pigments according to the Rf-values, is inverse on the non-impregnated plates, as compared with the plates impregnated by EGGER (1962) and RANDERATH (1966). Depending on the number of substituents the speed of migration is changed in opposite way by the two systems of separation, in case of carotinoids with oxygen (hydroxyl, resp. epoxyl) content (Fig. 2).

Tab. 1. Rf-values of pigments in the thin-layer

A = Kieselgur layer impregnated by RANDERATH (1962) and EGGER (1962) with subacid vegetable fat. Wash liquid: methanol-acetone-water, at a ratio of 20:4:3.

B = Silica gel-Cellulose powder, ratio 2:1, a non-impregnated layer used by us. Wash liquid: petroleum ether-benzene-absolute alcohol-water, at a ratio of 5:5:1:0,5.

Pigments	Rf-values		Number of Substituents	
	A	B	—OH	—O—
Chlorophyllide b	—	0,06	—	—
Chlorophyllide a	—	0,10	—	—
Neoxanthin	0,95	0,24	3	1
Violaxanthin	0,84	0,34	2	2
Lutein-epoxide	0,72	—	2	1
Lutein	0,56	0,38	2	0
Zeaxanthin	0,54	0,40	2	0
Cryptoxanthin	0,07	—	1	0
Chlorophyll b	0,25	0,49	—	—
Chlorophyll a	0,13	0,53	—	—
Protochlorophyll	—	0,57	—	—
Pheophytin b	0,07	0,69	—	—
Pheophytin a	0,01	0,73	—	—
Carotenes	0,00	1,00	0	0

2. Identification of pigments

From the intensive and characteristic colour of pigments we can easily conclude on the single colouring agents. From the intensity of colour and the size of stain we may carry out semi-quantitative evaluations, too. For an exact qualitative determination we have recorded absorption curves from the pure pigments by means of a Unicam SP 800 photometer, in different eluting media. The single colouring agents were identified on the basis of λ-maxima, as well.

Tab. 2. λ-maxima of chlorophylls in mμ, measured in red wavelength range.

Pigment	Eluting media			Metric data
	acetone	ethanol	methanol	
Protochlorophyll	664	666	667	own
Chlorophyll a	663 663	— 665	— 665	Müller's own
Chlorophyll b	645 645	— 650	— 651	Müller's own

The main carotinoids of the leaf get separated on the thin-layer applied without any transformation. The yellow colouring agents are, anyway, to be peeled off immediately after chromatography, before the evaporation of the wash liquid, since they suffer oxidative decomposition even in the dark. Even After standing 5 to 10 minutes, violaxanthin, neoxanthin and lutein-5, 6-epoxide change abready into a blue or bluish-green shade. This is manifested in the shift of maxima of the absorption curves towards the shorter wavelengths, in their general sinking and, later on, in their dissappearance. In case of peeling off in two minutes, these transformations do not occur. In a dissolvent and in the dark, on the other hand, even the epoxidic carotinoids mentioned above can be preserved without any alteration for a rather long time. The value of absorption maxima largely depends on the purity of the eluting medium, particularly on its water content.

We have determined from the separated pigments the absolute and relative quantity of the colouring agents as well as their processes of decomposition depending upon various factors. This, however, will be the topic of succeeding monographs.

Summary

We have elaborated a new extracting and thin layer chromatographic method for separating the leaf pigments.

Our procedure has the following advantages:

1. We use a new extracting technique whereby pigments are but slightly changed. The extract can immediately be used for chromatography, without any other process.

Tab. 3. The absorption λ-maxima of carotinoids in mμ

Metric data: (1)* = MÜLLER (1964),
(1)** = own measurement,
(2—4) = GOODWIN (1960).

Carotinoids	Eluting media			
	1 ethanol	2 chloroform	3 n-hexane	4 benzene
Carotenes	452, 482* 449, 475**	466, 497	425, 451, 482	
Cryptoxanthin		433, 463, 497	425, 451, 483	
Zeaxanthin	451, 480*	429, 462, 494	423, 451, 483	
Lutein	446, 476, 420* 444, 472, 420**	428, 456, 487	420, 447, 477	
Lutein-5, 6-epoxid	423, 445, 473*		442, 471	453, 482
Violaxanthin	441, 443, 471* 440, 468**	424, 451, 482	443, 472	454, 484
Flavoxanthin	422, 446, 400*	430, 459	421, 450	432, 481
Neoxanthin	415, 439, 466* 415, 437, 465**	447, 476	437, 466	447, 477

2. The green and yellow colouring agents show a clearcut separation on a plate, already after a single washing. The single zones can be peeled off neatly, thus permitting the qualitative investigation and quantitative determination of pigments.
3. The separation of colouring agents, together with extraction, does not take more than 45 minutes.

We are grateful to GÁBOR HORVÁTH for his versatile technical assistance.

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Acta Biologica Szeged 17 (1—4), pp. 79—87 (1971)

SPORE-POLLEN INVESTIGATION OF BORE-HOLE NO. 11 AT LŐKÖSHÁZA, WITH SPECIAL REGARD TO THE RECYCLED SPOROMORPHS

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(Received June 15th 1970)

Introduction

Several papers were published in recent years about the spore-pollen investigation of the recycled sediments. Palynology even as a method has proved suitable to ascertain by means of the presence of sporomorphs of older ages in the sedimentary rock investigated with more or less certainty not only the fact of recycling but also the age of the sediments recycled. In the literature of palynology nowadays several publications treat of the problem of denudation. Concerning method we may distinguish three main trends:

1. The classical method, the essence of which is the fundamental knowledge of the sporomorphs in various periods. On that basis, more types of denudation were separated from one another (GRICHUK, 1950; KRIVÁN and NAGY, 1963; WILSON, 1964; KEDVES, ENDRÉDI and SZELEY, 1966).
2. The separation of the recycled sporepollen grains by staining (STANLEY, 1966).
3. The separation of the recycled sporomorphs with fluorescence microscopy (VAN GIJZEL, 1966; 1967).

The materials of our investigation were the samples obtained from a depth of 0,00 to 8,20 m from the bore-hole No. 11 at Lőkösháza. The geological structure of the bore-hole is treated in the monograph of ANDÓ and MUCSI (1968). It is characteristic of the deep structure of the south-eastern territory beyond River Tisza that sea-torton and Miocene with Sarmatian sediments settled on the Palaeozoic and Mezozoic substrata. On which Panonian sediments have been stratified with transgression.

In the Pleistocene, the Hungarian Plain proceeded sinking. The site of river beds towards these sinking territories continually changed, their sediments were detrital cone-like. In the Holocene, the erosion of rivers, smaller and periodical. The character of sporadically standing water is marked by a clay-bearing, silty sediment.

Results

The bore-hole investigated by us falls on the area of a narrower ancient river valley. The underlayer of the Holocene valley bottom is silt, clayey silt between 4,3 to 8,2 m. The spore-pollen of Pleistocene in the two layers between

7,2 to 8,2 m is little, mainly as compared with the older sporomorphs of larger mass. The pollens of *Pinus silvestris* type are dominant, the mass of *Alnus*, *Betula* pollen is considerable, in a good condition characteristic of the quarter. In the layers between 6,0 to 7,2 m the dominance of conifers come to an end, there are more pollens of deciduous trees, from which the Quercus, Fagus, Carpinus, Juglans species can be determined; in the sample of 6,3 to 6,6 m we have found pollens of *Pinus cembra* type and *Ericaceae* (Plate IV, 11, 12), as well. It means the same as the *Trichia hispida* L. present alone here, marking a dry-cold climate in the *Mollusca* ensemble. The microfossils of the layer-line between 4,3 to 6,3 m from the Quaternary contain some species from standing water. The pollen of *Myriophyllum, Ceratophyllum* and the *Botryococcus* alga (Plate IV, 13, 14) show marsh conditions; *Cyperaceae, Typha, Equisetum, Alnus* and *Betula* are furnishing data about the combination of riparian vegetation.

The washing role of the ancient River-Maros entering the Hungarian Plain appears for the last time in the layers between 4,3 to 4,7 m in which, besides the uliginal genera coming from the inundation, a great many older sporomorphs can be found. The palynological results correspond to the malacological statements of ANDÓ and MUCSI (1968) who similarly determined a lacustrian, uliginal fauna.

The Pleistocene series of layer stops at 4,3 m. The spectrum rich in conifers of the layers between 7,3 to 8,2 may show the stadium of Würm while the pollen combination of layers above them marks an interstadial part. As a result of an intensive erosion in a warmer and more humid climate, the river spreading widely after entering the Plain had produced a flora and fauna of standing water in its inundations. This supposition is verified also by the sedimentary material as the silt clayey below ends at 5,7 m with a humous part of the layer. The humous sediment refers to a pause in reworking. Above it, at 4,3 m, is a blue clay-silt as closing layer, as a result of the reducing process of a state constantly under water. The Holocene valley formation begins at 4,3 m, with a new, weakened rhythm of the river activity the sediment of which between 1,4 to 4,3 m is micaceous, coarse-grained and rough sand mixed only with about 5 p. c. gravel of 1 to 7 mm in diameter. The pollen content of the sediment-proceeding upwards becoming finer — is very thin. The most of them are *Graminae* pollens that can mark between 1,2 to 1,4 m only the hazel phase of the ancient Holocene steppe period. For the phases of the ancient Holocene

Plate I

1,2. — *Toroisporis (Toroisporis) reissingeri* KEDVES & SIMONCSICS 1964, prep. Lökösháza, 4,9—5,3 m., 41,9/90,2.
3,4. — *Gleicheniidites (Triplexisporis) posttriplex* DÖRING 1965, prep. Lökösháza, 4,7—4,9 m., 32,2/94,8.
5,6. — *Gleicheniidites (Radiatisporis)* fsp., prep. Lökösháza, 4,7—4,9 m. 35,2/110,6.
7,8. — *Gleicheniidites (Triremisporites) minor* DÖRING 1965, prep. Lökösháza, 4,9—5,3 m., 44,6/94,2.
9,10. — *Gleicheniidites (Triremisporites)* cf. *minor* DÖRING 1965, prep. Lökösháza, 4,3—4,7 m., 41,3/109.
11,12. — *Gleicheniidites (Triremisporites) rasilis* (BOLCH. 1953) W. KR. 1959, prep. Lökösháza, 7,7—8,2 m., 45,1/105.
13,14. — *Gleicheniidites (Triremisporites)* fsp., prep. Lökösháza, 4,7—4,9 m., 30,3—90,1.

Plate I

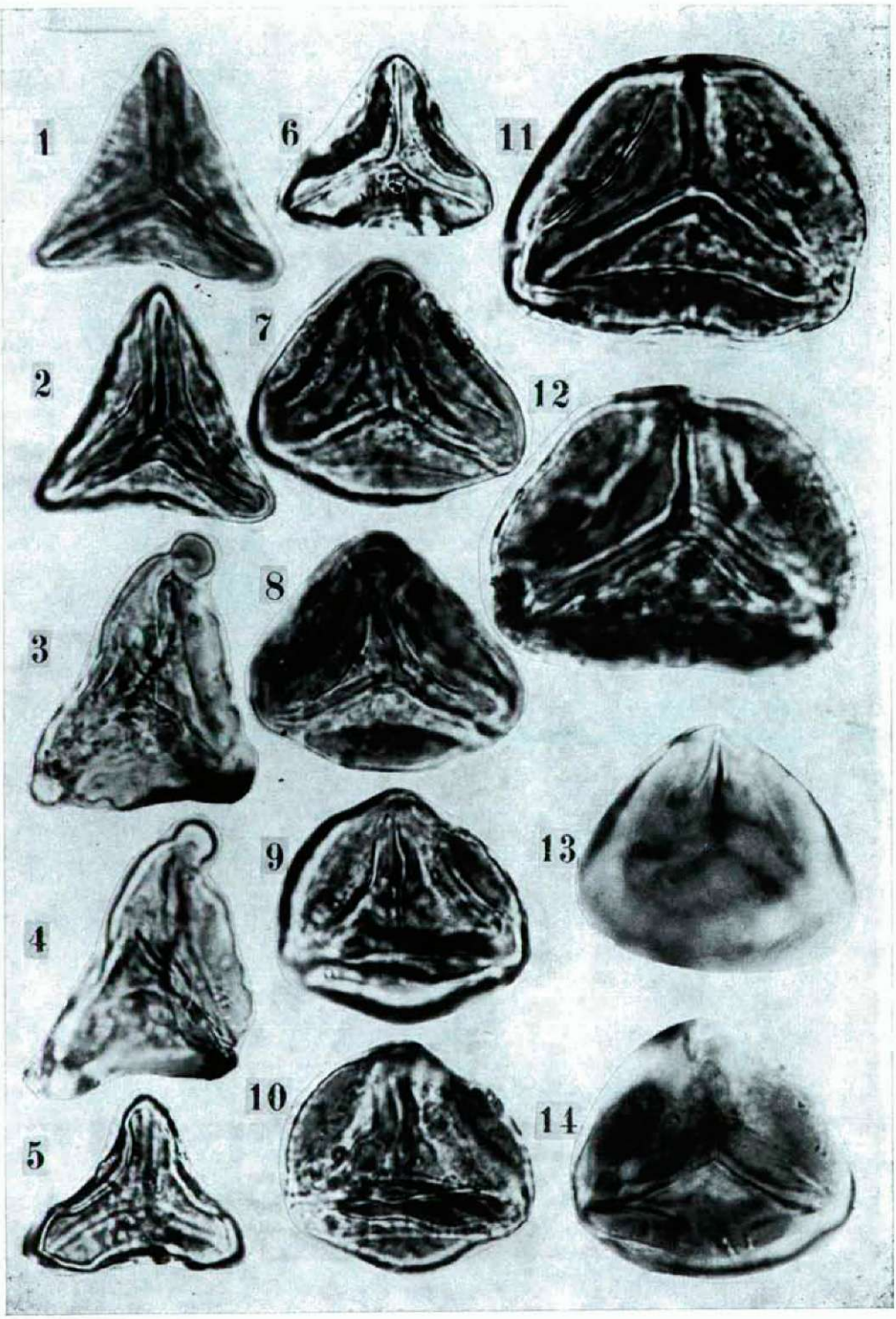
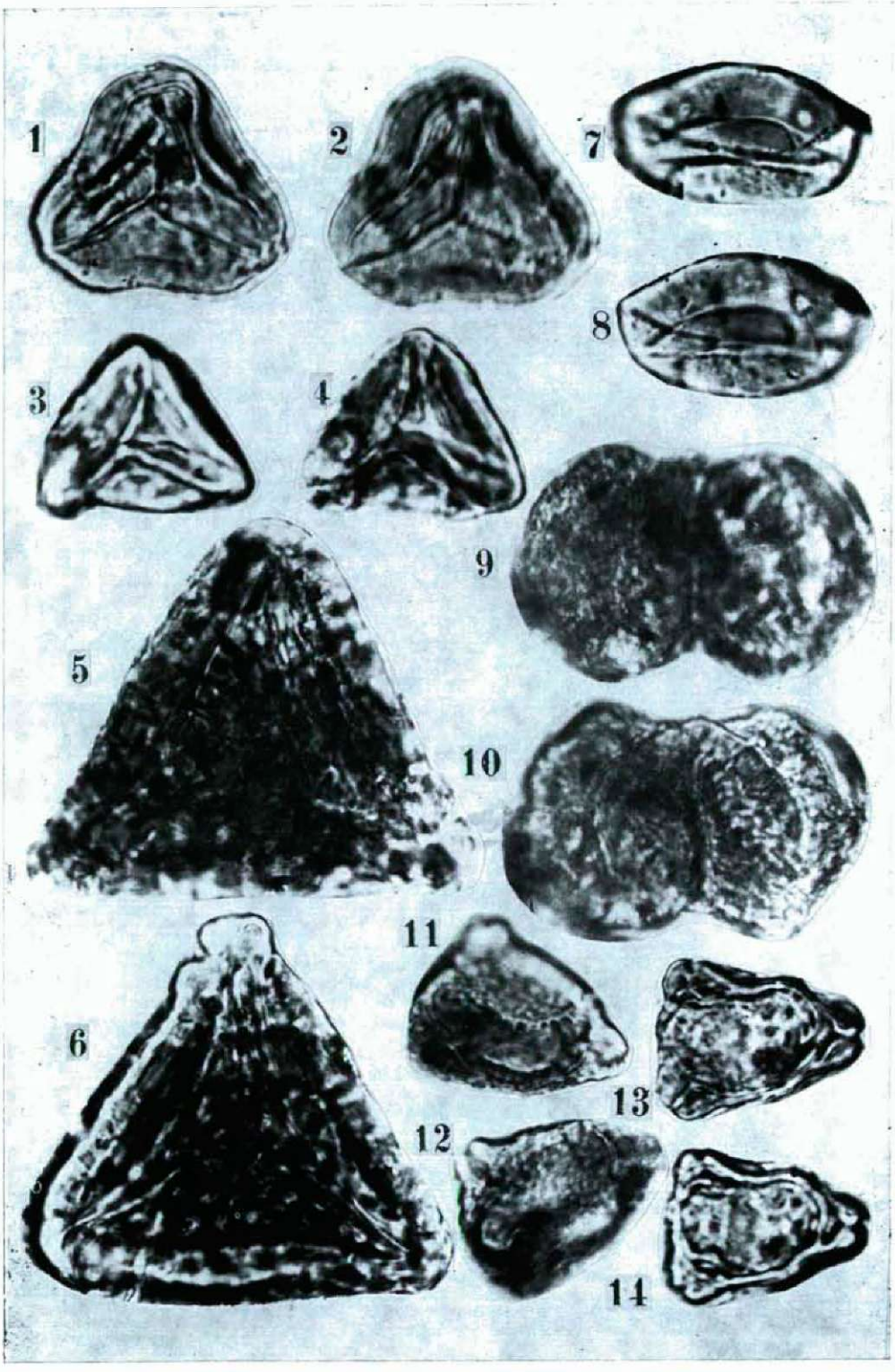


Plate II



vegetation we cannot give any palynological support. The pollen combination may have perished owing to frequent water coverage and desiccat ion.

Recycled sporomorphs. The investigation of these sporomorphs was performed with the mentioned classical method. The washing is complicated because more sediments of various ages were perishing in identical or nearly identical ages. The spores and pollens washed through are marking the denudation of the following layers:

1. Lower Cretaceous

We have observed first of all a large mass of Pteridophyte spores in very good condition. The morphology of these is referring to the Gleicheniaceae family of tropical character. We have determined the following taxa of the morphological system: *Toroisporis (Toroisporis) reissingeri* KEDVES et SIMONCSICS 1964 (Plate I, 1, 2), *Gleicheniidites (Triplexisporis) postriplex* DÖRING 1965 (Plata I. 3. 4), *Gleicheniidites (Radiatisporis)* fsp. (Plate I, 5, 6), *Gleicheniidites (Triremisporites) minor* DÖRING 1965 (Plate I, 7, 8; cf. 9, 10), *Gleicheniidites (Triremisporites) rasilis* (BOLCH. 1953) W. KR. 1959 (Plate I, 11, 12), *Gleicheniidites (Triremisporites)* fsp. (Plate I, 13, 14), *Gleicheniidites (Laticrassisporis* fsp.$_1$ (Plate II, 1, 2), *Gleicheniidites (Laticrassisporis)* fsp.$_2$ (Plate II, 3, 4), *Trubasporis* fsp. (Plate II, 5, 6).

Gymnospermatophyte pollen grains: cf. *Monosulcites* fsp. (Plate II, 7, 8), *Podocarpidites* fsp. (Plate II, 9, 10).

2. Upper Cretaceous

Only genus *Trudopollis* occurred, in our samples (Plate II, 11, 12). This age or the Lower Tertiarc period is referred to by cf. *Plicapollis pseudoexcelsus* (W. KR. 1958) W. KR. 1961 subfsp. *turgidus* PF. 1953 (Plate II, 13, 14).

3. Lower Tertiary

In contradistinction to the recycled sporomorphs of Lower Cretaceous, the following sporomorphs are less characteristic but in their totality they refer to the denudation of the sediments from the Lower Tertiary: *Stereisporites (Stereisporites)* fsp. (Plate III, 1, 2), *Toroisporis (Toroisporis) eocaenicus* KEDVES 1966 (Plate III, 3, 4), *Concavisporites (Concavisporites) arugulatus* PF. 1953 (Plate III, 5, 6), *Toroisporis (Toroisporis)* cf. *torus* (PF. 1953) W. KR. 1959 subsp. *major* PF. 1953 (Plate III, 7, 8), cf *Gleicheniidites (Toridistalisporis) toriconcavus* W. KR. 1959 (Plate III, 9, 10), *Polypodiaceoisporites* fsp. (Plate III, 11, 12), *Ephedripites (Ephedripites)* fsp. (Plate III, 13, 14), *Taxodiaceaepollenites*

Plate II

1,2. — *Gleicheniidites (Laticrassisporis)* fsp.$_1$, prep. Lőkösháza, 4,9—5,3 m., 29,6/98,3.
3,4. — *Gleicheniidites (Laticrassisporis)* fsp.$_2$, prep. Lőkösháza, 7,7/8,2 m., 37,6/114.
5,6. — *Trubasporis* fsp., prep. Lőkösháza, 4,3—4,7 m., 34,2/96,4.
7,8. — Cf. *Monosulcites* fsp., prep. Lőkösháza, 4,3—4,7 m., 30,5/103,1.
9,10. — *Podocarpidites* fsp., prep. Lőkösháza, 4,7—4,9 m., 30,9/90.
11,12. — *Trudopollis* fsp., prep. Lőkösháza, 4,9—5,3 m., 35,8/107,1.
13,14. — Cf. *Plicapollis pseudoexcelsus* (W. KR. 1958) W. KR. 1961 subfsp. *turgidus* PF. 1953, prep. Lőkösháza 7,2—7,7 m., 36/99.

biatus (R. POT. 1931) KREMP 1949 (Plate III, 15, 16), *Triatriopollenites* fsp.$_1$ (Plate III, 17, 18), *Triatriopollenites* fsp.$_2$ (III, 19, 20), cf. *Nipa* (Plate IV, 1, 2), *Intratriporopollenites microreticulatus* Mai 1961 (Plate IV, 3, 4), *Tricolporopollenites* ex gr. *cingulum* (Plate IV, 7, 8), *Tricolporopollenites* fsp. (Plate IV, 9, 10).

The stratigraphy of *Crassosphaera concina* COOKSON et MANUM 1960 (Plate IV, 15) is only imperfectly, as yet, it is without doubt that it derives from older Mezozoic or Lower Tetriary sediments. According to the data obtained so far, it marks a facies of mixed water.

Summary

The area investigated by us belonged to the territory carried down by the ancient River Maros. The erosion came mostly from the Transylvanian Erzgebirge and in smaller parts from basins farther away. In this area, along River Maros, since the Cretaceous a strong erosion has taken place (PÁVAI-VAJNA, 1914). According to our palynological data, in 4,3 to 5,3 m depth of the borehole we can denote first of all the denudation of sediments from the Lower Cretaceous, verified by the relative frequency of the forms of family Gleicheniaceae coming characteristically from the Lower Cretaceous. In a depth of 7,2 to 8,2 m rather the types of Tertiary (older than the Miocene) are in majority (e. g., *Intratriporopollenites microreticulatus* Mai 1961, cf. *Nipa*, etc.), accompanied by one or two pollens from the Upper Cretaceous.

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Plate III

1,2. — *Stereisporites (Stereisporites)* fsp prep. Lökösháza, 4,7—4,9, 37,5/106,5.
3,4. — *Toroisporis (Toroisporis) eocaenicus* KEDVES 1966, prep. Lökösháza, 4,7—4,9 m., 33/95.
5,6. — *Concavisporites (Concavisporites) arugulatus* PF. 1953, prep. Lökösháza, 4,7—4,9 m., 38,9/94,5.
7,8. — *Toroisporis (Toroisporis)* cf. *torus* (PF. 1953) W. KR. 1959 subfsp. *major* PF. 1953, prep. Lökösháza, 4,3—4,7 m., 44/97.
9,10. — Cf. *Gleicheniidites (Toridistalisporis) toriconcavus* W. KR. 1959, prep. Lökösháza, 4,7—4,9 m., 37,5/88,6.
11,12. — *Polypodiaceoisporites* fsp., prep. Lökösháza, 4,3—4,7 m., 37,2/106,7.
13,14. — *Ephedripites (Ephedripites)* fsp., prep. Lökösháza, 4,9—5,3, 44,5/94.
15,18. — *Taxodiaceaepollenites hiatus* (R. POT. (1931) KREMP 1949, prep. Lökösháza, 4,3—4,7 m. 38,3/110,4.
17,18. — *Triatriopollenites* fsp.$_1$, prep. Lökösháza, 5,3—5,7 38/105,1.
19,20. — *Triatriopollenites* fsp.$_2$, prep. Lökösháza, 7,2—7,7 m, 43,5/109,7.

Plate III

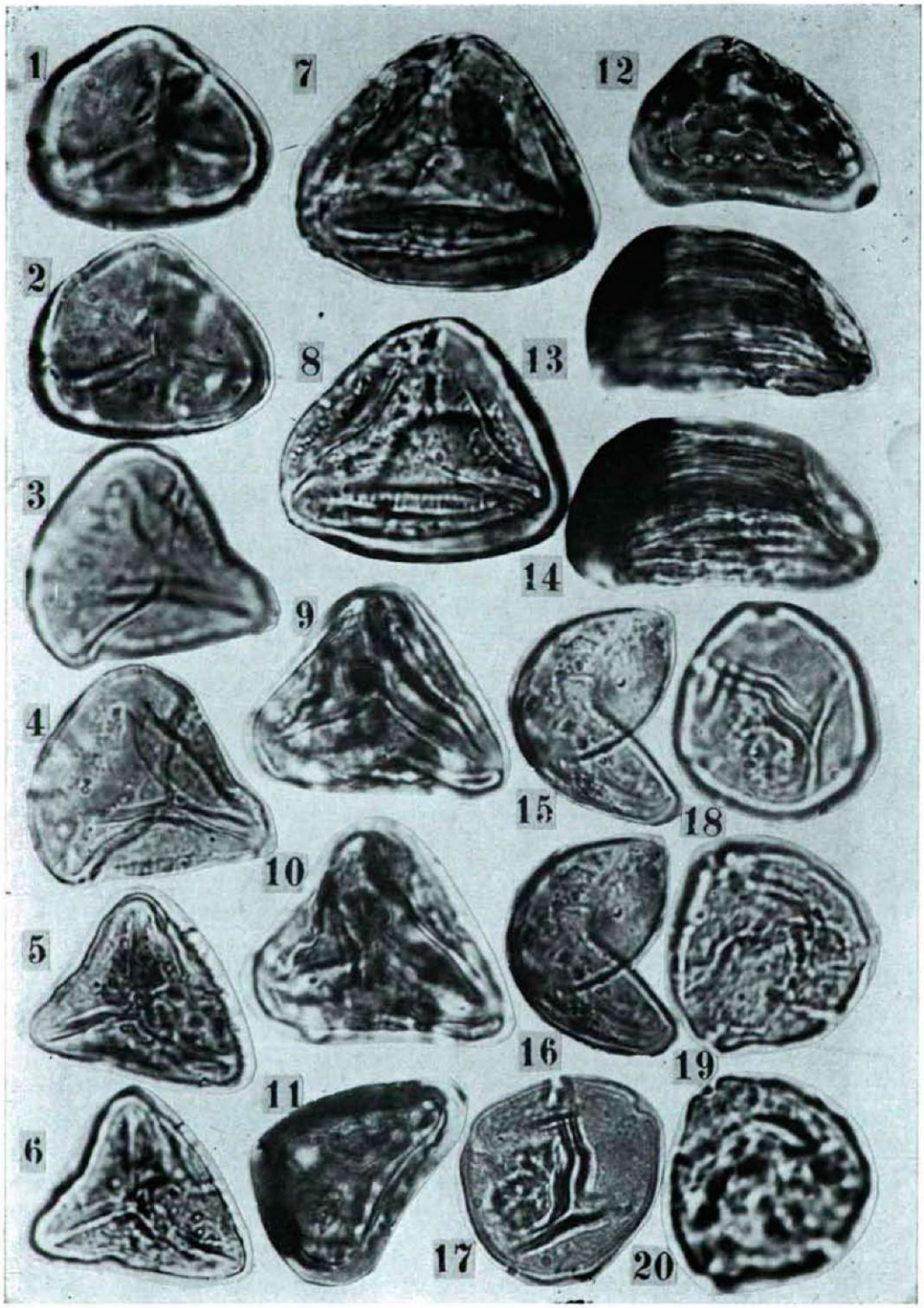

Plate IV

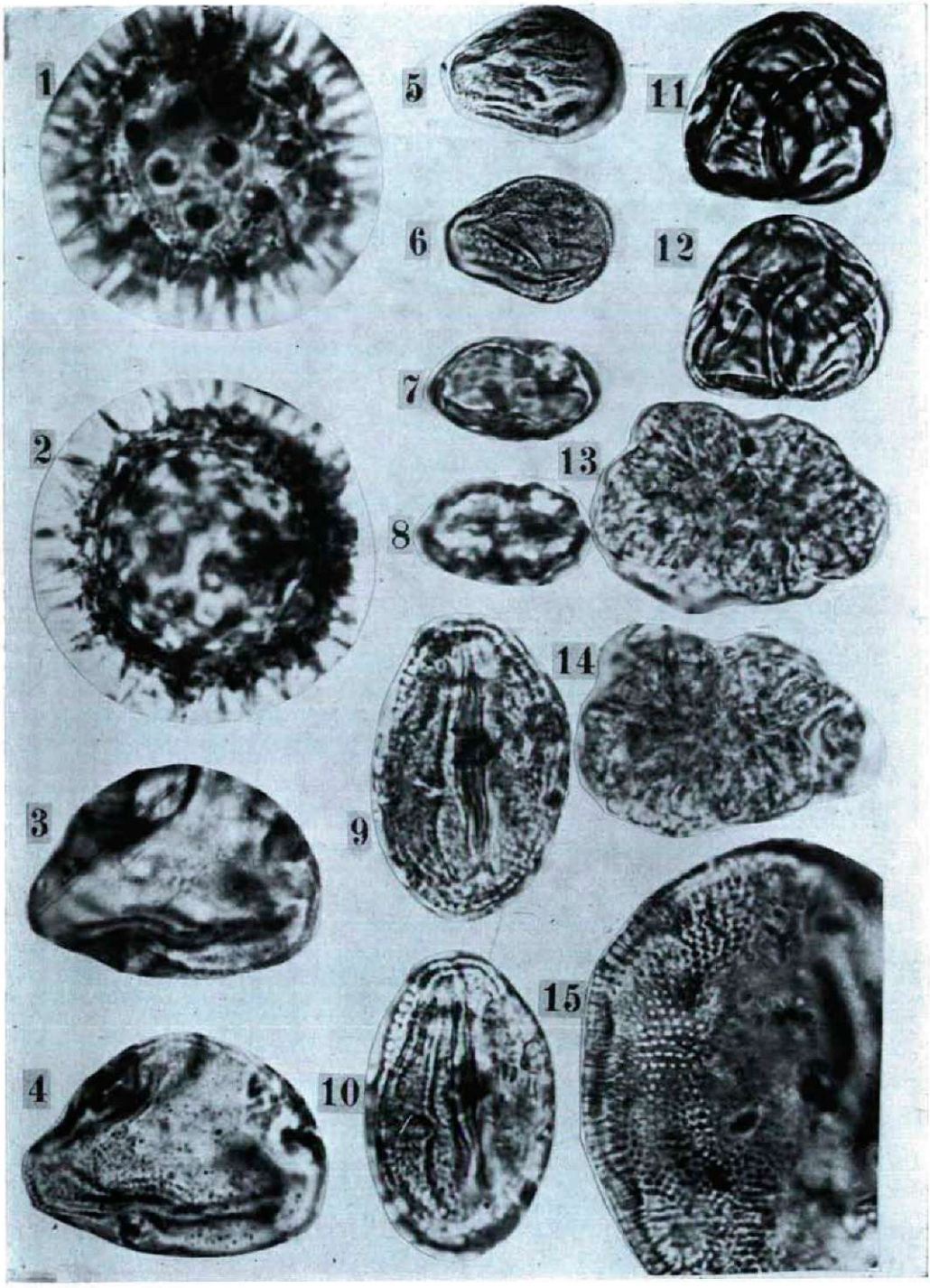

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Plate IV

1,2. — Cf. *Nipa*, prep. Lőkösháza, 7,7—8,2, 29,5/113.
3,4. — *Intratriporopollenites microreticulatus* Mai 1960, prep. Lőkösháza 4,3—4,7 m, 30,4/111.
5,6. — *Tricolporopollenites* ex gr. *microhenrici*, prep. Lőkösháza 4,9—5,3 m, 31/96,5.
7,8. — *Tricolporopollenites* ex gr. *cingulum* Lőkösháza, 4,9—5,3 m, 39,3/114,8.
9,10. — *Tricolporopollenites* fsp., prep. Lőkösháza 4,7—4,9 m, 35,5/98.
11,12. — cf. *Ericaceae*, prep. Lőkösháza 4,3—4,7 m, 35,5/108,1.
13,14. — *Botryococcus* fsp. prep. Lőkösháza, 4,7—4,9 m, 30,7/87,7.
15. — *Crassophaera concina* COOKSON et MANUM 1960 prep. Lőkösháza, 4,7—4,9, 36,9/103.

Acta Biologica Szeged 17 (1—4), pp. 89—103 (1971)

MULTIPLICATION OF THE ESSENTIAL AMINO ACIDS DURING THE LIVE-WILTING OF LEAVES

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(Received April 6, 1971)

The physiological processes in connection with the loss of water resp. wilting of leaves and shoots are little known although wilting is a common phenomenon in nature and practical life. Wilting takes place from the beginning of the cutting off of the green vegetables in the fields until the beginning of their ingathering, storing, commercial distribution and processing (spinach, garden sorrel, cabbage, common lettuce, etc). Savoys and garden cabbages gathered in great quantities in autumn lose their water gradually, i. e., they wilt during the winter storage. From the harvesting of fodder crop until their wilting in the open field, as well as during the processing of silage crops, too, the shoots separated from their root system continue wilting for a while.

Several researchers dealt with investigating the physiological processes during the water deficit, i. e. wilting of plants (KEMBLE and MACPHERSON, 1954; RADENKOVA, 1963; PETINOV, 1963; CHEN et al., 1964; BRITIKOV, 1965; BARNETT and NAYLOR, 1966; STEWART et al., 1966; GENKEL et al., 1967; DOVE, 1967; MARANVILLE, 1967, etc.). The practical usefulness of their findings, however, is often difficult to be realized since they carried out their experiments on various species and sorts of plants, on the leaves either of field plants or on those in culture pots or of intact ones, or on isolated leaves. Furthermore, even the same plant species were processed at different degrees of developments or grown under different external conditions.

In our experiments, we were interested, from among the physiological processes occurring in the course of the water deficiency of plants, first of all in the amino acid metabolism (PÁLFI, 1968, 1969; PÁLFI and JUHÁSZ, 1969, etc.). It is known that the free amino acid content of plants, resp. leaves is considerable, as compared to that of animal tissues, representing 1.5—1.8 percent of the dry matter. In case of plants, however, the ratio of the essential amino acids to the basal amino acids — both at free amino acids and in those bound into proteins — is unfavourable in regard to human alimentation.

The present investigations aimed at ascertaining whether the essential amino acid composition of the fresh leaves with an optimal water-balance or that of wilting isolated leaves is more similar to the human tissue extracts.

A further aim was to clear up how the dry matter, proline and total amino acid content as well as the amount of the soluble total protein, of isolated leaves develop in the light and the dark, while they lose water.

It was also examined whether during the water loss of the leaves isolated and infiltrated with 2.4-dinitrophenol the quantity of proline is growing, incubated in light, and how the abnormally high proline content of leaves is influencing that process.

In agriculture and in the practice of food industry it is important to know, under what conditions these plants have the most favourable nutriment composition during the storage of vegetables, the preservation of fodder-crops, hay-harvesting and ensilation.

Materials and Methods

The fully developed leaves of garden sorrel (*Rumex scutatus* L., variety, „Kerti") and of spinach (*Spinacia oleracea* L., variety, „Viroflay") were gathered at the end of the vegetative developmental phase. The garden cabbage for meals that was already capitate (*Brassica oleracea* L. var. *capitata)* was dissolved to its leaves for promoting its wilting. The shoots of lucerne (*Medicago savita* L., variety, „Lilavirágú) and the leaves of sunflower (*Helianthus annuus* L., variety, „Kisvárdai") were collected before the beginning of gemmation, and the shoots of maize at the age of 6—8 leaves (*Zea mays* L., variety, MVDC 300).

The water supply of the experimental field plants was for a rather long while at an optimum level in the time before sampling. The fresh and wilted variants of leaf-samples were previously apportioned into equal doses of 100.0 g fresh matter, in three repetitions. We have then dehydrated the variants putting them, after rinsing in tap water, on filter-papers, and incubating the leaf-groups of determined weight in the light or the dark for two days (at 25 °C, and a relative humidity of 70 percent). The control variants were fixed at 60 °C immediately after being rinsed, and weighed after being dried to constant weight.

For two days we have registered wilting weights in case of live-wilted variants, for being able to refer the results of protein detections to identical bases. The wilted variants were also dried at 60 °C, and the whole material was pulverized.

The qualitative and quantitative demonstration of amino acids was carried out by starting from the same amount of dry matter. One- and two -dimensional layer- and paper-chromatograms have been prepared from the extracts of every sample. The solvent of the first dimension was butanol-acetic acid-water (2 : 1 : 1), that of the second one phenol-water (4 : 1). The reaction to ninhydrin was fixed by copper-salt solution. The quantitative measurements of eluates, too, were carried out from copper complexes. The total amino acid determinations were performed with the comparative standards of eluates already published (PÁLFI, 1964a, b). The total amino acid data were checked up with Rosen's colorimetric procedure (1957), too. The proline measurements were accomplished with the isatin-colorimetric method and according to Chinard (1952). The soluble total protein extracted with tris-buffer (pH 7,5) was determined according to Lowry et al. (1951). During this procedure we have reduced the fresh and wilting weights to dry-weight, to get a real basis for comparison.

Experimental results

First we have studied in a many-sided way the effect of water deficiency, exerted on the amino acid metabolism of leaves, only on a single variety of a plant species (paprika, *Capsicum annuum* L. var. *longum* variety, „57—13"). The experiments included field-work and tests in culture media. Then we have investigated, how the members of various plant families, resp. the single plant species and cultivars behave in case of water deficiency and isolation of leaves, if the water loss was not retrieved. For that purpose we have investigated the free amino acid composition of the leaves of (mostly cultivated) plants belonging to 66 plant species, including leaves of *Gymno-* and *Angiospermae,* herbaceous and woody, *Mono-* and *Dicotyledons* including leguminous plants as well (PÁLFI, 1970).

It was found that up to a certain degree of live-wilting a large amount of total amino acid, resp. proline is accumulated in all the leaves investigated. The accumulation of free total amino acid in leaves in such a high degree (200—500 percent) that, owing to the water loss, it is connected with an extraordinary (1000—10 000 percent) increase of proline, was denominated by us an „amino acid metabolism of proline type" (PÁLFI, 1970). The development of the amino acid metabolism of proline type is, therefore, a general regularity, manifested widely in the world of plants, that was demonstrated by us at the most important families of the cultivated plants (*Solanaceae, Cruciferae, Leguminosae, Compositae, Gramineae,* etc.), too.

In the following we have endeavoured to find out whether the „amino acid metabolism of proline type" manifests itself exclusively as a result of water deficit or whether it can be caused also by another environmental factor. We have tried culture pot experiments with plants suffering from loss of N, P, K and other nutrients or supplied one-sidedly with plenty of a single nutrient. In addition, we have investigated the free amino acid composition of plants suffering from viruses, fungal or bacterial infections. From the results we have come to the conclusion that „amino acid metabolism of proline type" develops only as a result of water insufficiency. To be sure, in some cases of our comprehensive investigations we have noticed some signs of „amino acid metabolism of proline type" in spite of optimum water content of the soil.

In the course of the careful elaboration of data, however, it has turned out that the water uptake, resp. circulation was inhibited anyway (physiological dryness). Such inhibitor of water supply may be the high total salt content of the soil water in case of alkali soils, and cold soil (and cold air) in case of early plants or those surviving the winter (PÁLFI, 1969; PÁLFY and JÚLIA JUHÁSZ, 1969, 1970).

At any rate, if the total amino acid content of leaves is significantly above the normal level and the proline has increase by several hundred or thousand p. c., it can be ascertained undeniably on the basis of „amino acid metabolism of proline type" that the plant suffers from water deficiency (PÁLFY, 1969).

We hadn't any knowledge, either, in respect of whether „amino acid metabolism of proline type" manifests itself in every organ of plants as a results of water deficiency. For deciding the problem, we have grown wheat, paprika, and sunflower plants (cultivar „Bezostaya", Spice „57—13", and „Kisvárdai"). During a provoked strong water deficit the free amino acid extracts of leaves, stem ears, and roots were separately analysed. It turned out that „amino acid metabolism of proline type" manifests itself in any green organ of the plant, i. e., in any one containing chloroplastis, but not in the roots.

This results has suggested that photosynthesis may have a role in the development of „amino acid metabolism of proline type". For clearing the problem, we have ceased irrigating the culture pot paprika and sunflower plants (variety „57—13" and „Kisvárdai"), and kept them in the dark for ten days. As shown by the analysis of the daily taken leaf samples the proline and total amino-acid content of leaves may temporarily grow for a few days as a result of water deficiency, but in the days before withering the proline content entirely decreases and the free amino acid content drops also to a low level. Photosynthesis or its products have, therefore, a role in realizing, resp. sustaining „amino acid

metabolism of proline type". The development of „amino acid metabolism of proline type" is demonstrated in Fig. 1.

After ceasing to irrigation the culture-pot wheat plants (variety, „Bezostaya"), leaf samples were taken daily for eight days. The extracts of the collected samples have been developed on eight separate strips of a chromatogram-paper. After developing the amino acid spots, we framed the pale spots with a pencil and photographed them (Fig. 1).

On Fig. 1. it can be seen that the darkest and largest spots are made by proline but only from the second day after the watering was stopped (strips CDEFGH). In the leaf extract of the irrigated wheat (strip „A") proline appears only in traces (0,5 μg). As a result of water deficiency for seven days, that quantity has augmented 130 times (65μg). On Fig. 1 it can also be seen that, apart from proline, the amount of other amino acids has also increased considerably, (200—500 percent).

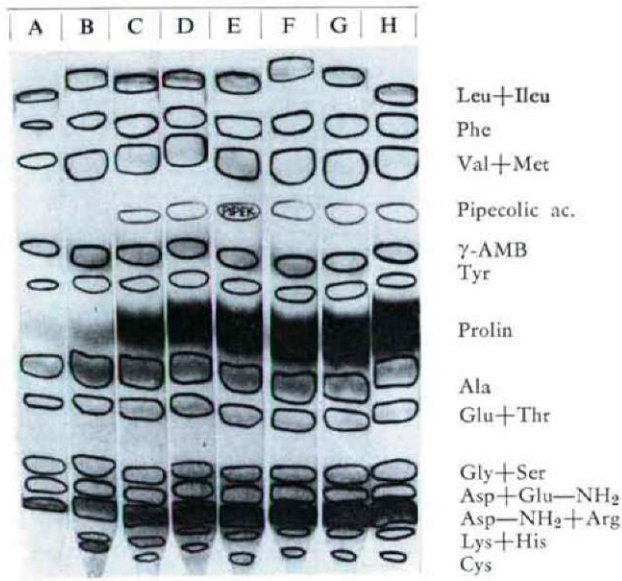

Fig. 1. The effect of the increasing water deficiency on the amino acids of wheat leaves. Culture-pot experiment. (Butanol solution; developer: isatine). „A"=constantly well-irrigated (control). „BCDEFGH"=increasing water deficiency as a result of interruption of the irrigation for 1, 2, 3, 4, 5, 6, 7 days

In the following we have investigated the amino acid spectrum of the leaves detached from the plants and losing water in isolated state. We have a ascertained that in the leaves losing water because being separated from the shoot, „amino acid metabolism of proline type" also develops like in the leaves of normal plants if they wilt exposed to light. Hence it follows that the wilting of isolated leaves is also a physiological process during which some biochemical changes similar to those in the leaves of intact plants become realized as a result of a strong water deficiency. An essential difference is that the amino acid accumulation, that developed during 3—6 weeks of water deficiency in

the normal field plants, takes but 3—4 days in leaves losing water in isolated condition. For emphasizing the water loss, in live state resp. wilting of the isolated leaves, we have denominated this phenomenon „live-wilting" (biodehydration). If the isolated, live-wilting leaves get light — they assimilate, meanwhile respiring — they dissimilate, generate energy, and consume. During live-wilting the water, dry matter, protein and carbohydrate content of the isolated shoots and leaves changes. The live-wilting depends therefore, (in a positive or negative way) on the production of organic matter, too. During live-wilting the proteinbuilding amino acids accumulate considerably and the proline concentration reaches an extremely high level.

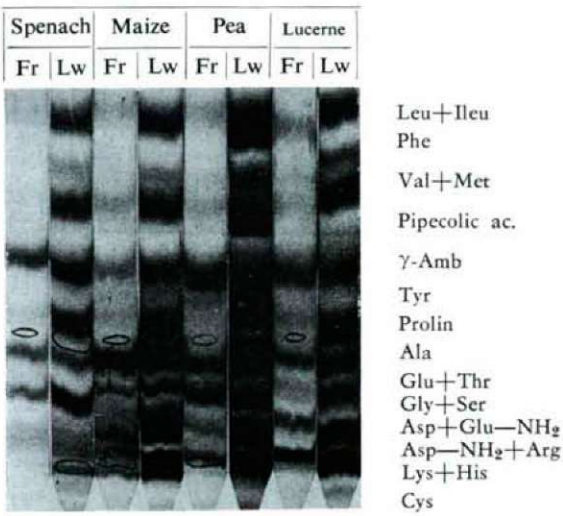

Fig. 2. Amino acids of leaves fixed and dried at isolation (fresh), as well as those dried after live-wilting for three days. Developer: ninhydrine. Fr=Dried fresh (control) Lw=Dried after live-wilting

It may supposed that with an artificial live-wilting process, as a result of a high-degree accumulation of free amino acids, green vegetables and animal fodderplants of concentrated protein value can be obtained. On the neighbouring strips of the chromatogram in Fig. 2, the extracts of the fresh and of the artificially live-wilted isolated leaves of the same plant occur alternately.

As shown by Fig. 2, the free amino acid content of the leaves fixed after the artificial live-wilting (LW), many times exceeds that of fresh leaves fixed immediately at isolation. That is particularly obvious in the upper part of some strips of the chromatogram where the spots of leucine + isoleucine, phenylalanine, valine and methionine is located. From the extracts of fresh leaves (Fr) these amino acids can be demonstrated in traces only. The essential amino acids occur in the fresh leaves in but a small amount. The ratio of essential and basic amino acids considerably changes owing to the live-wilting of the isolated leaves, as shown on Fig. 3.

It can be established from size and colour intensity of the spots of Fig. 3. that the free amino acid composition of the live-wilted pea and spinach leaves

resembles much more to the amino acid spectrum of human tissue extracts than that of fresh leaves. The leaves wilted by an artificial water deficiency approach more the ratio of the amino acids of human tissue extracts by increasing considerably the amount of a few essential amino acids (leucine + + isoleucine, phenylalanine, valine + methionine, threonine, arginine, histidine and lysine). From the spots of Fig. 3 we can draw also the conclusion, that the total amino acid content of the live-wilted leaves is a manifold plural of that of fresh leaves fixed at isolation.

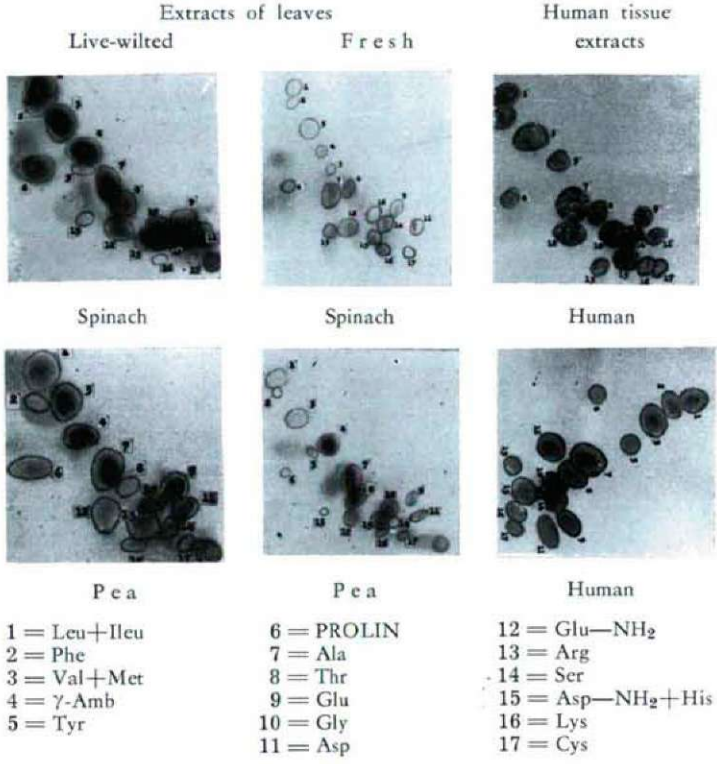

Fig. 3. Free amino acids of plant and human tissue extracts

The quantitative data of the amino acid increase appearing during live-wilting are published in Table I.

Isolated shoots of maize and lucerne and leaves of the other plants were wilted.

It can be seen on Table I that the proline content of the cabbage and sunflower leaves, live-wilted in light, exceeds that of fresh leaves more than a hundred times. At the same time, the proline accumulation of the leaves of garden sorrel and spinach does not reach the tenfold value of the fresh variant. In the degree of proline increase there are therefore, considerable differences

according to plant species. It is worth mentioning, too, that garden cabbage, paprika, wheat, and sunflower, we could obtain even 6—7 percent pure free proline content, as a result of a live-wilting in light for 4 to 5 days (referred to dry matter). This quantity can easily be obtained after boiling in distilled water. It may be ascertained, anyway, that the proline accumulation is considerable in each of the plants investigated, as compared to the fresh control it is at least 500 per cent.

Table 1

Change of the free proline and total amino-acid contents of isolated leaves, as a result of live-wilting in the light and in the dark.
Garden cabbage and maize wilted alive for three days, the other plants for two days.

Plants	Proline				Total amino acid			
	mg/g dry matter			Per cent increase in dry matter of fresh leaves; light	mg/g dry matter			Per cent increase in dry matter of fresh leaves; light
	Fresh leaves	Live-wilting leaves			Fresh leaves	Live-wilting leaves		
		light	dark			light	dark	
Garden sorrel	0,32	1,7	0,9	531	15,7	47,6	43,2	303
Spinach	0,38	2,2	1,3	578	16,2	68,6	56,5	423
Garden cabbage	0,40	42,4	32,7	10 600	16,3	92,8	68,4	569
Maize	0,29	12,8	9,3	4413	20,2	66,3	54,1	328
Lucerne	0,46	15,3	8,4	3326	17,1	57,2	50,3	334
Sunflower	0,25	26,6	10,8	10 640	12,6	41,5	32,7	329

The total amino acid is to be understood without asparagine but with proline.
Deviation of standard error of the three repetitions of the variants is less than ±8 per cent

Table I shows also, that in the plants investigated the increase of the total amino acid, owing to the live-wilting in the light, is of very high degree, between 300 and 600 percent (in the percentage of the fresh matter).

Such outstanding increase of the amino acid contents can be achieved even by live-wilting only in case of leaves that are well supplied in regard to mineral nutrition and have due carbahydrate reserves, but not in case of under-nourished and weakened plants. At our live-wilting experiments carried out frequently with garden cabbage, we have obtained more than once 10 p. c. total amino acid contents. A garden cabbage like that can be considered in itself as an amino acid concentrate since 1 kg dry matter contains 100 g free amino acid.

It can be seen on Table I that the proline and total amino acid content of leaves live-wilted without light did also considerably increase as compared to that of the fresh ones. The accumulation of amino acid in the dark is, however, considerably smaller in case of all the six types of the plants investigeted that that of the variants wilted in the light. Other experimental results (PÁLFI, 1968, 1969) show that in the next days of the lightless live-wilting even this quantity decreases and, until the time of full drying, it drops to the level of control.

In the following we are investigating the changes in dry matter and soluble total protein accompanying the increase of the total amino acid during the live-wilting (Table II). At weighing the dry matter we have weighed previously, in three repetitions, 100,0 g doses of fresh matter for every variant; then, after two days exposition in the light or in the dark, the doses were fixed and dried.

Table 2

Change of the dry matter and the soluble total protein contents of isolated leaves, as a result of live-wilting in the light and in the dark.
Garden cabbage and maize wilted alive for three days, the other plants for two days.

Plants	Dry matter from 100 g fresh matter				Soluble total protein mg/g fresh matter			
	Fresh leaves; g	Live-wilting leaves, g		Change in the p. c. of the fresh leaves; light	Fresh leaves; g	Live-wilting leaves g		Change in the p. c. of the fresh leaves; light
		light	dark			light	dark	
Garden sorrel	14,06	14,76	13,82	+4,9	16,4	16,3	15,7	−0,6
Spinach	10,25	9,88	9,58	−3,6	20,2	20,5	19,8	+0,4
Garden cabbage	9,84	9,62	9,54	−2,2	9,4	9,1	8,6	−3,2
Maize	16,25	16,96	16,03	+4,3	17,9	18,5	16,5	+3,3
Lucerne	22,68	22,35	21,54	−1,5	32,6	31,9	29,7	−2,2
Sunflower	12,36	13,08	12,10	+5,8	12,3	12,2	11,7	−0,9

The records of total protein of the live-wilted variants take into consideration the water loss as compared to the fresh ones.

It appears from Table II that during live-wilting in the light the dry matter of leaves increases in three plants but decreases in other three species. The change is, however, so small as compared to the control that, with consideration to the maximal deviation of standard error (± 5 p. c.), it is not significant (except the sunflower). At the variants incubated in the dark, however, the dry matter of all the six species decreased more or less. We have obtained similar results from the investigations of the soluble total protein, as well. During a short exposition (two days) in the light the water-loss, inducing high-degree increase of the total amino acid, did not cause any significant decrease in protein.

The soluble total protein content of the variants incubated in the dark, parallel with the dry matter, has decreased in case of all plants investigated. From that we can draw the conclusion that a considerable decrease in dry matter implies a decrease in protein. It may be established that the light, resp. the photosynthesis has, also in case of leaves living isolated and losing water, a considerable part in regard to the quantitative changes in total amino acid, dry matter and soluble total protein.

In the course of our experiments, we have infiltrated isolated tobacco leaves (variety, „Szabolcsi") with the 100 ppm aqueous solution of 2,4-dinitro-

phenol. According to the results of analyses carried out daily during the live-wilting in the light, there was no considerable increase of proline in any day till the full withering (PÁLFI, 1968a, 1969a, c). At the same time, in the control leaves infiltrated by water, the „amino acid metabolism of proline type" developed already in the second-third day of live-wilting, and we have demonstrated a significant increase of proline even at the full withering of leaves. On the basis of our experimental results we suppose that in the course of live-wilting the precursor of the large quantity of proline is glumatic acid (PÁLFI, 1968a, b) formed from carbohydrates by means of oxidative phosphorylation. This pathway is, however, uncoupled by 2,4-DNP.

We have also performed experiments in the course of which we live-wilted isolated tobacco leaves for two days. Then it was shown that a considerable amount of free proline has already accumulated. The already live-wilted leaves, with high free proline content (1,0 p. c.), infiltrated by the solution of 2,4-DNP, were again live wilted in the light. The quantity of free proline went on growing (2,0 p. c.).

The experiment was carried in by infiltrating further isolated tobacco leaves with the aqueous solution of proline (0,5 p. c.). Beginning next day, we live-wilted the same leaves in the light for three days, after infiltrating them with the solution of 2,4-DNP, increasing in that way the proline content of leaves from 0,5 to 2,3 per cent (as referred to dry matter). In case of a considerable proline reserve of the isolated leaves, therefore, or by means of proline infiltration, 2,4-DNP has no uncoupling effect on oxidative phosphorylation during live-wilting.

As established, „amino acid metabolism of proline type" manifests itself in any phase of development of the plants (PÁLFI, 1969a, b, c); but the largest amount of proline and total amino acid accumulates in the „critical period of water supply". In case of herbaceous plants this period falls on the time of microsporogenesis (FRENYÓ, 1959; PETINOV and BERKÓ, 1965; SZALAI, 1968; SATILOV and IKONNIKOV, 1969).

Discussion

We have studied the free amino acid composition of the leaves of *Gymno-* and *Angiospermae,* herbaceous and woody, *Mono-* and *Dicotyledons,* (mostly crop plants) belonging to 66 species, in case of water deficiency (PÁLFI, 1968a, b; 1969a, b, c; PÁLFI, 1970; PÁLFI and JUHÁSZ 1970).

The accumulation of the free total amino acid in leaves in such a high degree (200—500 percent) that involves an extraordinary (1000—10 000 percent) increase of proline, was denominated an „amino acid metabolism of proline type". The „amino acid metabolism of proline type" is a normal phenomenon, current in the plant kingdom. In the course of our multi-sided investigations we have ascertained that „amino acid metabolism of proline type" develops only as a result of water deficiency or of physiological dryness, in case of cold soil or of a high salt content of the soil water (MARIA GOAS, 1968; HEBER, 1969; PÁLFI and JUHÁSZ, 1968, 1969, 1970).

It was proved that the demonstration of „amino acid metabolism of proline type" of plants may be used also for diagnostic characterization of the water

deficiency of plants (PÁLFI, 1969b) and for selecting drought resistant plant types.

We have also ascertained that „amino acid metabolism of proline type" manifests itself only in the green organs of plants containing chloroplastis; but not in the roots. The results of the culture pot water deficiency experiments carried out in the light and in the dark have demonstrated that photosynthesis or its products have some role in realizing, resp. preserving „amino acid metabolism of proline type" (PÁLFI, 1968b, 1969a, c; MORRIS et al., 1969).

Since „amino acid metabolism of proline type" occurs also when isolated leaves are losing water in the light, the wilting of leaves isolated from plants is also a physiological process. By „live-wilting" we mean the continuous, „increasing water deficiency" of isolated leaves or shoots for two-three days (biodehydration). It was found that with an artificial live-wilting process, as a result of a high-degree accumulation of free amino acids, green vegetables and animal fodder plants of concentrated protein value could be obtained. We have established, too, that the ratio of essential and basal amino acids becomes much more favourable to the purposes of human alimentation, as a result of the live-wilting of isolated leaves, because the accumulation of some essential amino acids during live-wilting is by far superior to that of the basal amino acids (leucine, isoleucine, phenylalanine, valine, methionine, etc.).

In the course of water deficiency, resp. live-wilting essential differences werefound between the various plant species in regard to proline increase. During live-wilting in the light, the proline accumulation in the leaves of garden sorrel and spinach does not reach the tenfold amount of the fresh control, while the proline content of the leaves of garden cabbage and sunflower exceeds that of fresh leaves more than a hundred times.

We have established that the increase of total amino acids, as a result of artificial live-wilting under illumination, is of very high degree, ranging from 300 to 600 per cent (in the percentage of control, i. e. of the non-wilted dry matter). Such extremely high accumulation of free amino acids can be achieved only in case of leaves that are well-supplied with mineral nutriments and have considerable carbohydrate and nitrogen reserves, but not in case of the leaves of under-nourished, weakened plants.

The live-wilting processes lasting two-three days in the light have shown that no significant change either in the dry-weight of leaves or in the amount if the soluble total protein, while the total free amino acid and particularly the proline accumulates in high degree (garden sorrel, spinach, garden cabbage, maize, lucerne, sunflower).

As to proteins, a similar statement comes from TVORUS (1970), as well. In our opinion, the cause of the high-level amino acid accumulation is that in case of water deficiency the preponderance of protein synthesis over protein decomposition ceases to be (FARKAS, 1963, 1968; DÉZSI et al., 1970). The growth of cells and cell-walls, as well as cell division are stopped. At the same time, in the leaves the synthesis of protein-building amino acids goes on for a while undisturbedly in fact it is often intensified in the initial period of water deficiency (CHEN et al., 1964; BRITIKOV, 1965; SAVITSKAYA, 1965, 1967; BARNETT and NAYLOR, 1966; STEWARD et al., 1966; DOVE, 1967, etc.) as long as the carbohydrate and N-reserves of leaves are not used up. The plant suffering from water deficiency does not continue to grow. In case of strong

water deficiency, metabolic activity is interrupted between some organs of the intact plant, i. e., the leaves, the stem and root, as well as the growing points (meristems), (BRITIKOV et al., 1965; DOVE, 1967). In such cases the circulation and removal of some water-soluble materials are stopped, among them that of the compounds regulating the metabolism (PÁLFI, 1970). And also the outflow from the leaves of the synthetized organic matters, including amino acids and carbohydrates, stops too (THOMPSON et al., 1966). In case of strong water deficiency the laves of intact plants also behave like isolated leaves (DOVE, 1967; PÁLFI, 1970).

In case of water stress, the same biochemical processes take place in the leaves of intact plants as in the isolated leaves. The process lasts as long as the plant does not reach a critical physiological state because of water deficiency. A 60—70 per cent water loss of leaves, is already followed by slow necrosis.

If the synthesis of proteins and nucleic acids did not decrease at a time of strong water deficiency (UDVARDY and MÁRIA HORVÁTH, 1964; CHEN et al., 1964; DOVE, 1967; MÁRIA HORVÁTH and LONTAI, 1968; PROCENKO et al., 1968; VLASYUK et al., 1968; TVORUS, 1970, etc.), then we could expect a considerable protein increase instead of the large amount of free amino acid, resp. proline, during the live-wilting of the isolated leaves in the light.

As already demonstrated by STEWART et al. (1966), in case of water deficiency the carbon-chain (α-ketoglutarat) and energy (ATP) for synthesis and accumulation of the amino acids are supplied by the oxidation of sugars. In case of artificial live-wilting it is therefore most important that the isolated leaves have due carbohydrate and nitrogen reserves. From among amino acid, the dicarbon-acids occur in plant proteins only in form of amides (glutamine, asparagine), as stated by STEWART and co-workers. As under the influence of water stress the positive organic matter production, resp. the synthesis of proteins decreases (and therefore the cell division and growth are stopped) there are comparatively more amides discharged from, than incorporated into the proteins. For synthesis and transamination of amino acids the NH_2-groups are supplied, apart from the inorganic nitrogen, by this amide surplus.

KEMBLE and MACPHERSON (1954) did not consider the wilting of grasses after being cut as a physiological process and regarded the accumulation of free amino acids as the result of simple proteolysis. RADENKOVA (1963), PETINOV (1963), and BRITIKOV et al. (1965), as well as SAVITSKAYA (1965, 1967) described the amino acid resp. proline accumulation in connection with the water loss of leaves as a specific defensive reaction of plants, where the role of proline was interpreted with complex functions. According to STEWART et al. (1966), the presence of reserve carbohydrates in indispensable for the amino acid and proline accumulation in the isolated leaves wilting in the dark.

According to the authors, the inhibitors of the tri-carbon-acid cycle impede the accumulation of proline in case of water stress. These data are supported also by the results of our own experiments concerning the saccharose infiltration before wilting (PÁLFI, 1968a, 1969a, c), as well as by the results of our 2,4-dinitrophenol-infiltration experiments for uncoupling the oxidative phosphorylation (PÁLFI, 1968a, 1969a). As a matter of fact, no proline accumulation takes place either in the light or in the dark in leaves infiltrated by 2,4-DNP.

If prior to live-wilting a considerable amount of proline has already accumulated in leaves, or they have been infiltrated with proline solution the accu-

mulation of proline contineus during subsequent live-wilting in the light, in spite of the treatment with 2,4-DNP. It may be supposed that the free proline takes part in the regulation of respiration, as well, by forming NAD-H_2 or NADP-H_2, in case of its transformation into glumatic acid, to the oxidation of which is connected, as a substrate of the terminal oxidation, a great part of the ATP synthesis of the cell (FARKAS, 1968).

BRITIKOV and LINSKENS (1970) infiltrated spinach and maize leaves with proline and foung that the normal respiration of tissues is considerably stimulated by proline. Camille HUBAC (1967) infiltrated rape-seedlings with proline and found that drought resistance is vitalized by proline in case of water stress. Similar conclusion were drawn by TYANKOVA (1966, 1969), KÜDREV (1967), and PAVLOV (1969), as well.

During live-wilting of isolated leaves for two days is turned out, that without light both the dry matter and the soluble total protein decreased in the leaves of all the six plants investigated. This fact is also supporting the important role of photosynthesis, resp. of its products, the carbohydrates, in the amino acid metabolism during live-wilting (STEWART et al., 1966; SZÁSZ et al., 1969; MORRIS et al., 1969). In regard to the nitrogen source it night be suggested that the plants under optimum conditions have always at their disposal some potential, reserve nitrogen for a further amino acid and protein synthesis resp. for protoplasm and cell growth. In case of water deficiency this potential nitrogen can still be used at the amino acid sythesis but no further protein increase can be realized any more. The quantity of the rest nitrogen of leaves can be increased by supply of nitrogen through the leaves before being cut off (PÁLFI, 1960) or by nitrogen infiltration after isolation (with a 0,01—0,1 p. c. solution of ammoniumphosphate or -nitrate or urea, as well as 0,5—1,0 p. c. saccharose solution).

The artificial „live-wilting" (bio-dehydration) of isolated leaves and shoots, is under legal defence, as a Hungarian patent. Its title: „Method of procedure for producing plant preparations enriched with free amino acids" (November 26, 1969).

Summary

1. We have named „amino acid metabolism of proline type" the high-degree accumulation (of 200—500 per cent) of free amino acid in leaves that is accompanied by an extraordinary, proline increase of 1000—10 000 p. c. It was found that „amino acid metabolism of proline type" only develops as a result of water deficiency or of physiological drought. „Amino acid metabolism of proline type" is a general regularity quite current in the plant kingdom. The demonstration of proline with an isatine-paper indicator may be used also for characterizing diagnostically the water deficiency of plants, as well as for selecting the drought and frost-resistant plant varieties.

2. The devalopment of „amino acid metabolism of proline type" was equally demonstrated in the course of water loss of isolated leaves in the light and thus the wilting of isolated leaves is also a physiological process. By „live-wilting" we mean the uninterrupted, „increasing water deficiency" of the isolated leaves or shoots, lasting for 2—3 days (bio-dehydration).

3. As a result of the artificial live-wilting, taking place in the light and under optimal conditions, the accumulation of the free total amino acid is, of very high degree, ranging from 500 to 600 per cent, in the percentage of the dry matter of not wilted, i. e. fresh leaves (garden sorrel, spinach, garden cabbage, maize, lucerne, sunflower). During live-wilting in the light for 2—3 days there was no significant changein the dry weight and soluble total protein content of leaves while the free amino acid content of leaves was multiplied. At the same time, in case of isolated leaves, live-wilted in the dark, the amount both of dry matter and of the soluble total protein considerably decreased and the increase of free amino acid was also inferior to that of its light vairant.

4. In case of strong water deficiency the leaves of intact plants also behave as isolated leaves. The same biochemical processes take place in case of water stress in the leaves of intact plants, as isolated leaves.

5. In case of water deficiency, the carbon-chain and energy for the synthesis and accumulation of amino acids are supplied by the oxidation of saccharoses (α-ketoglutarat + ATP). It is therefore important that the isolated leaves should have due carbohydrate reserves before live-wilting and that the intensity of photosynthesis should not excessively decrease for 2—3 days, as yet.

6. As a result of water deficiency, comparatively more amides are discharged from the protein than are incorporated since plasm increase and cell division are stopped. For the synthesis of amino acids the NH_2 groups are supplied, apart from the inorganic nitrogen, by this ammonia surplus.

7. During live-wilting in the light there was no considerable increase of proline-content if the leaves were previously infiltrated with 2,4-DNP. The production of proline from carbohydrates takes place by means of the oxidative phosphorylation, uncopled by 2,4-DNP. If, however, the leaves had contained, already a considerable amount of proline (0,5—1,0 p. c.) prior to 2,4-DNP-treatment, the effect of 2,4-DNP did not manifest itself, and the accumulation of proline continued in the course of live-wilting. It may be supposed that the free proline participates in the regulation of respiration as well, for, if the proline is transformed into glutamic acid, a reducing potency ($NAD \rightarrow NADH_2$) is released that can be used for the ATP synthesis.

8. It was found that, with an artificial live-wilting process, as a result of high-level accumulation of amino acids, green vegetables and fodder plants of concentrated protein value can be obtained. We have demonstrated that the ratio of the essential and the basal amino acids becomes much more favourable for human nourishment, as a result of the live-wilting of the isolated leaves.

9. It was found that „amino acid metabolism of proline type" manifests itself in any phase of the development of plants. The largest amount of proline and total amino acid however, is accumulated in the „critical period of water supply". In case of herbaceous plants this period falls on the time of micro-sporogenesis.

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Acta Biologica Szeged 17 (1—4), pp. 105—112 (1971)

KANN DIE HOHE LAGERUNGSTEMPERATUR ALLEIN EINE NACHTRÄGLICHE WIRKUNG AUF DEN ERNTEERTRAG AUSÜBEN?

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(Eingegangen am 9. Juni 1971)

In einer landwirtschaftlichen Produktionsgenossenschaft in der Umgebung von Szeged wurden in 1969 mehrere hundert Hektare mit „Gülbaba"-Kartoffeln bebaut; infolge des besonders schlechten Keimungsprozents gab es auf 40—45 Prozent der Kartoffelfelder überhaupt keine Ernte und selbst unter den anscheinend kräftig gewachsenen Pflanzen entwickelten sich nur sehr wenige Knollen. Laut der allgemeinen Ansicht, hat — in diesem Fall — die ungünstige hohe Lagerungstemperatur die Verminderung des Ernteertrages hervergerufen.

In Ungarn werden, mangels moderner Speicheranlagen, die Kartoffelknollen in zahlreichen Produktionsgenossenschaften und Staatsgütern in der „althergekömmlichen" Weise, d. h. in Prismen aufgestapelt, mit Stroh und Erde überdeckt, gelagert. Zwar konnten Praxis und Erfahrung eine wennschon nicht moderne, so doch akzeptable Form dieser Lagerungsmethode entwickeln, doch können bei dieser Methode unverteilhafte Änderungen in den Keimen der Knollen eintreten, die die homogene Keimung und somit auch den Ernteertrag sowohl in qualitativer als auch in quantitativer Hinsicht gefährden.

In der erwähnter Produktionsgenossenschaft wurden im Jahre 1969 mehrere hundert Tonnen „Gülbaba" Saatkartoffeln auf offenem Feld in Prismen gelagert. Die Prismen waren je 1 Meter breit und 25 Meter lang. Die nachstehende Abbildung verdeutlicht diese Lagerungsmethode (Abb. 1).

Neben ihrer Billigkeit und den schier unbegrenzten Möglichkeiten hat diese Lagerungsmethode auch mehrere Nachteile, und zwar:

1. teils wegen der Knollenmenge und teils wegen der Deckschicht ist eine Regelung der Temperatur fast unmöglich;
2. es ist recht unständlich, den Zustand der Knollen zu beobachten und die etwaige Knollenfäulnis festzustellen;
3. auf der Oberfläche und im Inneren der Prisme befinden sich die Knollen nicht unter denselben Verhältnissen, sind also ungleichen Wirkungen zugänglich.

All diese Nachteile bedeuten aber lediglich gewisse Schwierigkeiten der Kontrolle, ohne jedoch die Güte und Menge des Ertrages in einschneidender Weise zu gefährden.

Im vorliegenden Fall wurden folgende Mängel der Lagerung festgestellt:

1. das Lattengitter zur gleichmäßigen Lüftung der Knollen wurde nicht benützt (Abb. 1);

2. man wehrte sich nicht ausreichend gegen die respirationverursachte Erwärmung, die Temperatur der Prismen war unzulässig hoch (11—14 °C anstatt 3—7 °C);

3. in den erwärmten Prismen erfolgte die Keimung der Knollen frühzeitig; die Prismen mußten geöffnet werden, um die Keime zu entfernen.

Die erste Frage, die geprüft werden mußte, lautete: in welchem Maße wird der Respirationsverlust vom Temperaturanstieg der Prisme erhöht?

Aus früheren Versuchen standen uns mehrere Angaben über die Höhe der Lagerungstemperatur und des Respirationsverlusts zur Verfügung, die auf der nachstehenden Tabelle angeführt sind (Tab. I).

Tabelle I. Respirationsverlust bei verschiedenen Lagerungstemperamenturen

Sorte	1 °C	6 °C	16 °C
Frühe Rose	9,2%	8,3%	20,7%
Kisvárdaer Rose, Ella	9,8%	8,0%	21,2%
Gülbaba, Bintje, Pierviosnek	11,8%	4,9%	20,0%
Margarete	11,6%	11,6%	15,4%

Aus diesen Angaben geht hervor, daß der Respirationsverlust der untersuchten Arten bei 6 °C am geringsten ist. Infolge niedrigerer (+ 1 °C) und höherer (+ 16 °C) Temperaturen nahm der Respirationsverlust gleichmaßen zu und erreichte bei 16 °C den Höchstwert von 21,2%. Das verbleibende Knollengewicht von nahezu 80% genügt aber reichlich zur Bildung normaler und kräftiger Keime (Abb. 2), es ist also nicht begründet, im respirationsbedingten Gewichtverlust (innerhalb gewisser Grenzen) einen determinierend Faktor des Ernteertrages sehen zu wollen. Zweifellos hat die ungünstige (steigende) Lagerungstemperatur in der Prisme einen kräftigen Entkeimungsprozeß ausgelöst. Zur Veranschaulichung dieser Wirkung der Lagerungstemperatur möchte ich die Angaben des Versuchsinstituts von Braunschweig-Völkenrode dokumentieren (Tab. II).

Tabelle II. Prozentuelle Keimungsrate der Lagerung bei verschiedenen Lagerungstemperaturen

Reifegruppe	5 °C	15 °C
Früh	1%	27,3%
Mittelfrüh	0,5%	24,2%
Mittelspät	0,3%	16,9%
Spät	0,2%	7,5%

Nach der Rücker zu den Angaben der Tabelle II, gelangen wir zur Schlußfolgerung, daß die Erwärmung der Prisme auf 12—14 °C eine kräftige Keimung der Knollen bewirkt. Es fragt sich nun, ob dieser Umstand einen nennenswerten Verlust bedeutet. Zahlreichen einschlägigen Versuchsergebnissen nach

bedeutet die für die frühen Sorten charakteristische Keimung während der Lagerung (im Februar) keinen besonderen qualitativen Verlust, denn an Stelle der abgebrochenen Keime entwickeln sich gewöhnlich mehr neue Keime, als an sortenechten Knollen, die während der Lagerungszeit nicht keimten.

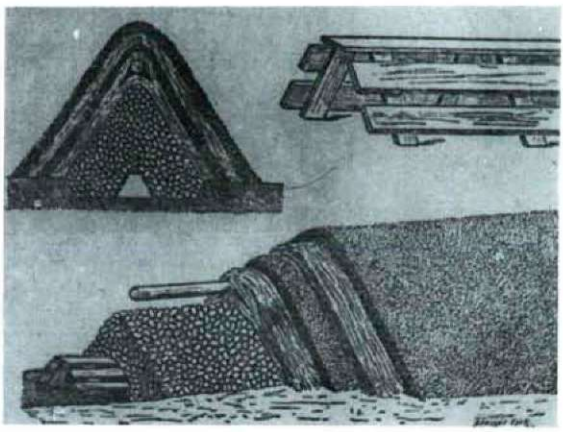

Abb. 1. Skizze der Kartoffelprismen auf offenem Feld.

Abb. 2. Saatkartoffeln guter Qualität, bei 14—16 °C im Keller gelagert, entwickeln auch nach erheblichem Respirationsverlust (20—26% kräftige Keime (Foto I. Szalai).

De sich bei einem beträchtlichen Teil der angebauten mittelspäten „Gülbaba"-Knollen nur ein oder wenige Sprossen entwickelt haben (Abb. 3), war der Gedanke naheliegend, bei den mittelspäten Sorten sei die Keimung während der Lagerungszeit nachteilig oder es müßten auch andere Parameter in Betracht gezogen werden, denn bei einem beachtlichen Teil der angebauten Knollen fand die Bildung der gleichmäßig und schnell wachsenden stämmigen Keime nicht statt; vielmehr bildeten sich nur Fadenkeime bzw. kurze Stolonen, auf denen sekundäre Knollen oder „Zwiewüchse" entsanden (Abb. 4). Am 2. Juni 1969 fand ich in den stichprobenartig ausgehobenen Stauden ausnahmslos Mutterknollen, die solche Zwiewüchse entwickelten (Abb. 5—6).

Einige Aufnahmen, die an Ort und Stelle gemacht wurden, dokumentieren, in welchem Maße die Kartoffelsaat im behandelten Falle aufgegangen war und die Knollenbildung erfolgte (Abb. 7—8).

Abb. 3. Aus der Mutterknolle „Gülbaba", gelagert bei hoher Temperatur, entwickeln sich zumeist gar keine oder nur verkümmerte oberirdische Triebe. Solche Stücke sind zur Knollenbildung unfähig (Foto I. Szalai).

Abb. 4. Aus den degenerierten Saatknollen enwickeln sich nach Anbau kurze Stolonen und an diesen sekundäre Knollen. In diesem Falle bilden sich keine oberirdischen Triebe (Foto I. Szalai).

Nach den Gesagten konnte der Ernteausfall nicht mehr ausschließlich der viel zu hohen Lagerungstemperatur zugeschrieben werden, man müßte die Ursachen auch in der Qualität der Saatknollen suchen.

In den Tiefebenen mit warmen, trockenen Sommern — so auch in einem ansehnlichen Teil Ungarns — erfolgt im Verlauf der ständigen vegetativen Vermehrung eine Degenerierung der Kartoffeln. Diese Verfallserscheinung ist kein typisches ungarisches Problem, sondern tritt in allen ähnlichen oder noch weiter südwärts gelegenen Ländern überall auf. Es wurde festgestellt, daß die hohe Bodentemperatur, die Ende Juni und im Juli während der Entwicklungs- und Reifeperiode der Knollen besteht, die Hauptrolle unter den Natur- und Zuchtfaktoren spielt, die sich auf die Entwicklung der Pflanze nachträglich auswirken.

Die Knollen, die sich bei hoher Temperatur, in einer mehr oder weniger anhaltenden Trockenperiode entwickeln, treiben im Frühjahr größtenteils dünne,

sog. „Fadenkeime" (STEINECK). Die Zahl der fadenkeimigen Knollen ändert sich von Jahr zu Jahr und beträgt des öfteren bis zu 80—90 Prozent der Gesamtzahl. Die schwachen Keime dieser Knollen sind unfähig den Boden zu durchbrechen, folglich wird der Kartoffelbestand ungleichmäßig und der Ernteverlust hoch.

Abb. 5. Bildung sekundärer Knollen am Untersuchungsmaterial, entnommen dem Kartoffelfeld der Produktionsgenossenschaft Keine oberirdischen Triebe (Foto I. Szalai).

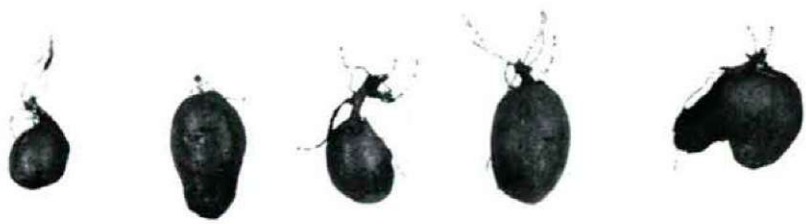

Abb. 6. Unter den gut entwickelten Pflanzen bildeten sich zur Fortplanzung ungeeignete Knollen aber nicht an den Stolonen des oberirdischen Triebes, sondern an den degenerierten Mutterknollen (Foto I. Szalai).

Über die „Fadenkeimigkeit" und ihre Ursachen sind bereits zahlreiche Mitteilungen erschienen, die die Ursachen fast ausnahmslos in der hohen Bodentemperatur und in der unzureichenden Wasserversorgung sehen (SORAUER, KOLTERMANN und APPLEMAN). DYKISTRA nennt die Fadenkeimigkeit eine vorübergehende physiologische „Erkrankung". Bei seiner Untersuchung an der Kartoffelsorte „Bintje" war die Fadenkeimigkeit vielfach mit der Bildung durchwachsener Knollen verbunden. ZOGG, HOBBER und SALZMANN untersuchten in 1948 die stark fadenkeimige „Bintje"-Sorte und führten die Ursachen einmütig auf die große Dürre und die hohe Bodentemperatur im Sommer 1947 zurück.

Laut FISCHNICH und Mitarbeiter können die fadenkeimigen Knollen mit wiederholtem Abbrechen der Keime zur Bildung besserer Keime angeregt werden, doch dürfen die Knollen in diesem Falle nur nach Vorkeimung in den Boden gebracht werden, da der Anbau unmittelbar nach Entfernung der Keime die Mutterknollen sehr oft zur Bildung sekundärer Knollen anregt. So ist also auch die Bildung der „Zwiewüchse" eine Begleiterscheinung der physiologischen Degenerierung.

In der Frage der Bildung von sekunderen Knollen oder Zwiewüchsen liefert BODLAENDER einen entscheidenden Beweis:

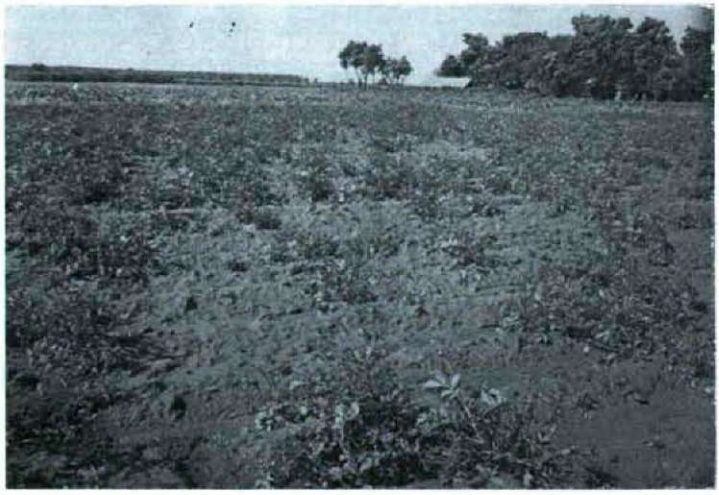

Abb. 7. Infolge der Verwendung der physiologisch degenerierten Saatknollen „Gülbaba" ist die Entkeimungsrate sehr schawach (ca. 50%). Aufgenommen am 27. Juni 1969 in der Produktionsgenossenschaft „Úttörő", Makó (Foto I. Szalai).

1. Er stellt fest, daß sich bei hoher Bodentemperatur (28—30 °C) — unabhängig von der Wasserversorgung — an der Mutterknolle sekundäre Knollen oder Zwiewüchse entwickeln, solche Fälle jedoch bei 16—18 °C niemals vorkommen.

2. Die Dürre hat das Phänomen nicht intensiviert.

3. Er stellt ferner fest, bei gleichen Bedingungen käme die Bildung der sekundären Knollen an Langtagbedingungen häufiger vor, als an Kurtzagbedingungen.

4. Die Stickstoffdüngung über dem Optimum löst ebenfalls die Neigung zur Bildung der sekundären Knollen aus.

5. Im Laufe der Knollenentwicklung verkürzt die hohe Bodentemperatur die Ruhe der Knolle (sie wird anfällig zur Keimung während der Lagerung), vermindert die apikale Dominanz und fördert dadurch die Verzweigung der Stolonen sowie die Bildung der sekundären Knollen.

Anhand der eigenen Versuchsergebnise und der Dokumente der Fachliteratur konnte festgestellt werden, daß die von der Produktionsgenossenschaft „Úttörő" gekauften und aus verschiedenen Standorten stammenden Knollen zum Teil physiologisch degeneriert waren.

In der endgültigen Stellungnahme war auch der glückliche Umstand behilflich, daß die an derselben Stelle in gleicher Weise gelagerten, aus Eigenbau stammenden und bestimmt gesunden Kartoffeln in der Prisme nicht keimten und nach dem Anbau kräftige Triege entwickelten. Infolgedessen ging die Staat gleichmäßig, nahezu hundertprozentig auf (Abb. 9—10).

Aufgrund all dessen wurde begutachtet, daß die Lagerungsmethode nur teils Schuld an der minderwertigen Qualität der Sattknollen trägt und daß die

Abb. 8. Aus den unter ungünstigen Verhältnissen gelagerten „Gülbab"-Knollen entwickeln sich häufig, trotz kräftiger oberirdischer Belaubung, keine oder nur wenige Stolonen; keine oder nur unbedeutende Knollenbildung (Foto I. Szalai).

Abb. 9. Bei Verwendung von physiologisch gesunden Saatknollen geht die Saat hundertprozentig auf. Aufgenommen am 27. Juni 1969 in der Produktionsgenossenschaft „Úttörő", Makó (Foto I. Szalai).

Abb. 10. Unter der dichtbelaubten Pflanze, die sich aus dem selbstgezüchteten Saatgut der Produktionsgenossenschaft entwickelte, ist die Knollenbildung befriedigend. Aufgenommen am 27. Juni 1969 in der Produktionsgenossenschaft „Úttörő", Makó (Foto I. Szalai).

Ursachen hauptsälhlich in den Saatknollen liegen, die sich unter nicht optimalen Verhältnissen entwickelt haben, scheinber tadellos, in wirklichkeit jedoch physiologisch degeneriert worden sind.

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Acta Biologica Szeged 17 (1—4), pp. 113—118 (1971)

ON THE MECHANISM OF GIBBERELLIN – AUXIN INTERACTION VII. EFFECTS OF GIBBERELLIC ACID ON THE UTILIZATION OF AUXIN PRECURSORS IN INDOLEACETIC ACID SYNTHESIS

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(Received April 26, 1971)

Introduction

We have demonstrated in earlier works that in bean hypocotyl tissues the gibberellic acid (GA_3) treatment raises the level of the endogenous indoleacetic acid (IAA). In the GA-treated stem tissues, in vivo, the concentration both of the free and bound IAA increased considerably (VARGA and BITÓ, 1968; VARGA, KÖVES and SIROKMÁN, 1968). According to our data, the GA-induced increase of IAA level ensues much more by promoting the biosynthesis of auxin from tryptophan (TTP) than by decreasing the auxin destruction (VARGA et al., 1968; VARGA and BITÓ, 1967). De demonstrated the stimulation of the TTP → IAA conversion by GA also in an in vitro growth system (VARGA, 1972).

SASTRY and MUIR, (1965) observed in their experiments carried out with Avena coleoptiles that the TTP-induced elongation was of comparatively low degree but it increased in the presence of GA, showing that the conversion of TTP into IAA in the coleoptiles was stimulated by GA directly. Taking into consideration these results, we have carried out further investigations with bean stem segments concerning the influence of GA on the utilization of TTP and other auxin precursors in the IAA synthesis. These experiments were also suitable for studying the problem in what path-ways the TTP → IAA conversion in bean stem tissues is realized.

Materials and Methods

10 mm segments were cut out, immediately under the cotyledons, from the hypocotyl of five-day-old bean seedlings (*Phaseolus vulgaris* L. var. *Golden Rain*) grow in the dark. Ten pieces of segments were floated in a Petri dish on 5 ml test solution, at 24°C, in dark, for 24 hours. The solution contained 0,05 M phosphate buffer (pH 6.0), 0.05 M sucrose, as well as GA, IAA, various auxin precursors or their mixtures in different concentrations. As auxin precursors TTP, indoleacetonitrile (IAN), indoleacetaldehyde (IAAld) and tryptamine (TNH_2) were used. The length of the segments was measured after incubation and the elongation was expressed as Δ mm exceeding the control value ($n = 4 \times 10$).

Origin of the chemicals used: GA_3: Phylaxia Budapest; IAA: Merck AG Darmstadt; TTP, IAN and THN_2: Fluka AG Buchs SG; IAAld: Sigma Chem. Co. St. Louis.

Results and discussion

The effect of various concentrations of TTP, IAN, IAAld and TNH_2, inducing stem elongation, can be studied — as compared to that of IAA — in Fig. 1. The highest degree of lengthening was produced — although on a lower level as compared to IAA — by TTP, the reaction optimum is at 10^{-5} M. The effect of IAN was somewhat smaller than that of TTP but still pronounced,

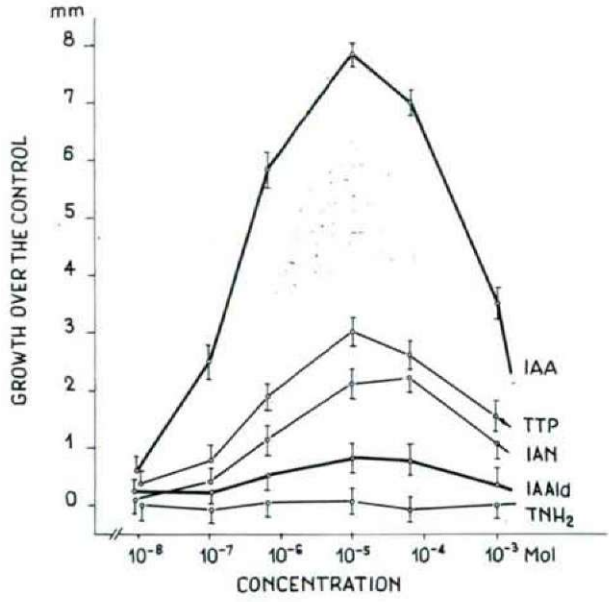

Fig. 1. Effect of some IAA-precursors on the elongation of the subapical hypocotyl segments of bean.

with a concentration optimum of 10^{-4} M. After applying IAAld in an interval of 10^{-6} to 10^{-3} M, only a little growth-stimulating effect could be observed; and TNH_2 proved to be ineffective in any concentration. The hypocotyl segments of bean contain, therefore, enzymes converting TTP, IAN and probably IAAld into auxin, as well. The most important intermediary of the TTP → IAA pathway is apparently IAN, in a smaller degree IAAld; but the reaction-way leading through TNH_2 seems to be missing in the stem tissues of bean.

Now it is questionable whether the elongation of the segments incubated in TTP and IAN can be increased by adding GA at the same time. The joint effect of TTP and GA is demonstrated in Fig. 2. As perceptible, the interaction of TTP and GA depends on the concentration. The synergistic effect between 10^{-5}, 10^{-4} and 10^{-3} M GA and 10^{-5} M TTP is obvious. But synergism can be observed, however to a lower degree, also with the two lower TTP concentrations. That means that the TTP → IAA conversion is increased by GA, at least in cases of TTP concentrations like these.

After simultaneously applying GA and IAN (Fig. 3), definite synergism manifested between 10^{-5} to 10^{-3} M GA and any concentration of the precursor and particularly 10^{-5} M. In this growth system, the biological effect of IAN is

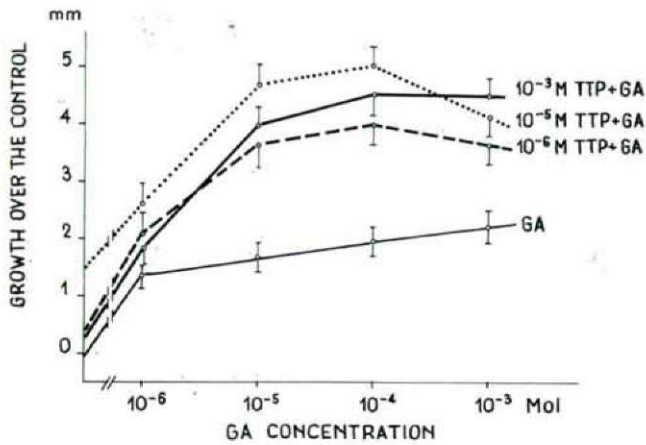

Fig. 2. Joint effect of GA and TTP on the elongation of the stem segments of bean.

therefore increased by GA, what is possible obviously only by increasing in some way the utilization of the precursor in IAA-formation.

In the presence of 10^{-5} M IAAld with 10^{-5} to 10^{-3} M GA, a synergism exceeding the standard error but in a small degree was observed; GA exerted, therefore, only a very little effect on the elongation induced by this precursor.

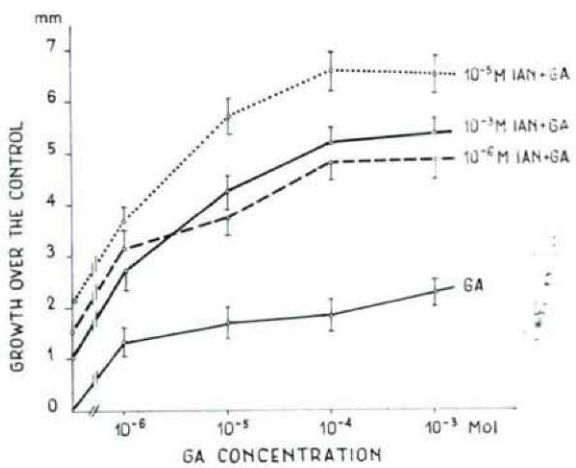

Fig. 3. Joint effect of GA and IAN on the elongation of the hypocotyl segments of bean.

GA had in the experiments of SASTRY and MUIR (1965) also a little effect on the IAAld-induced growth, from what it was concluded that GA took part in the TTP → IAA conversion before the aldehyde state. We interpret the small physiological effect of IAAld rather by saying that the path-way of IAA-biogenesis through indolepyruvic acid — indoleacetaldehyde in the bean stem tissues is of lower importance.

the pigment components chlorophyll-a is decreasing the most expressedly and,

In connection with the above-mentioned experiments it seemed to be necessary to investigate the kinetics of the stem elongation stimulated by IAA and TTP, as well as by TTP + GA. The time curves of the elongation of stem segments are demonstrated in Figs. 4 and 5.

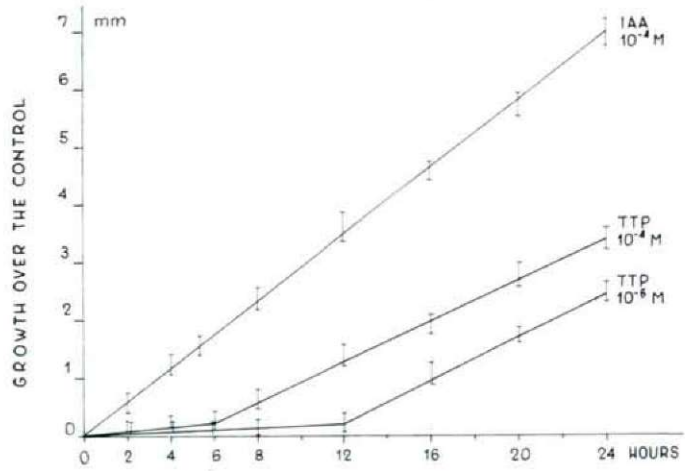

Fig. 4. Time curves of the growth-stimulatory effect of IAA and TTP.

According to the data in Fig. 4, the TTP-induced stimulation begins only after a definite lag-period; the lag proved to be 5 to 6 hours in case of TTP of maximum effect 10^{-5} M, and 10 to 12 hours after applying 10^{-6} M TTP inducing a smaller elongation. In all probability, this time is necessary for the critical amount of auxin to be produced from TTP in the stem tissues. This suppositon is strongly supported by the experience that the stimulatory effect of IAA has no perceptible lag-period.

The duration of the lag observed at the incubation in TTP was shortened by the simultaneous adding of GA (Fig. 5). The explanation of that is obviously that the TTP → IAA conversion is promoted by the increase of the endogenous GA-concentration.

Summary

In bean stem segment test, the growth-stimulating activity of tryptophan (TTP), indoleacetonitrile (IAN), indoleacetaldehyde (IAAld) and tryptamine (TNH_2) was investigated, in the presence and absence of gibberellic acid (GA_3).

Applying TTP + GA, IAN + GA, as well as IAAld + GA jointly, a definite synergism manifested itself in the elongation of segments. The biological effect of these auxin-precursors is stimulated by GA apparently by the increase of their utilization in the IAA-formation.

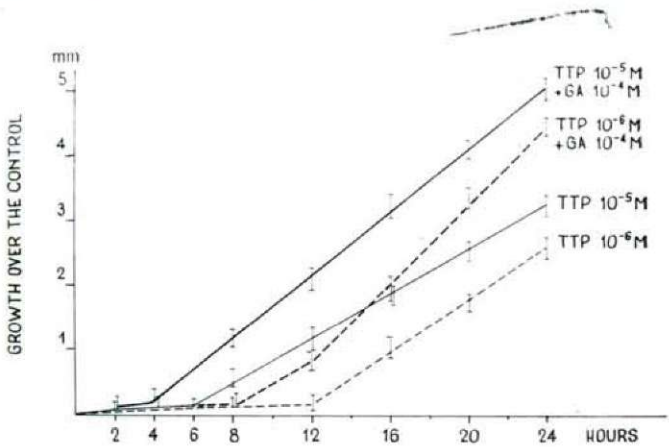

Fig. 5. Effect of GA on the kinetics of the TTP-induced growth

The stimulation of the TTP-induced growth takes place, dependent upon concentration, only after a lag-period of 5 to 12 hours. The duration of lag is shortened by the presence of GA that similarly indicates the promotion of TTP → IAA conversion by GA.

In bean shoots, the biosynthesis of IAA from TTP is mainly realized through IAN, but a less important path-way through IAAld can also be demonstrated. On the other hand, the conversion of TNH_2 into auxin could not be observed in the test object.

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Acta Biologica Szeged 17 (1—4), pp. 119—122 (1971)

CHANGE IN THE PIGMENT CONTENT OF AUTUMN WHEAT 1201 FROM BÁNKÚT

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(Received June 10, 1970)

Introduction

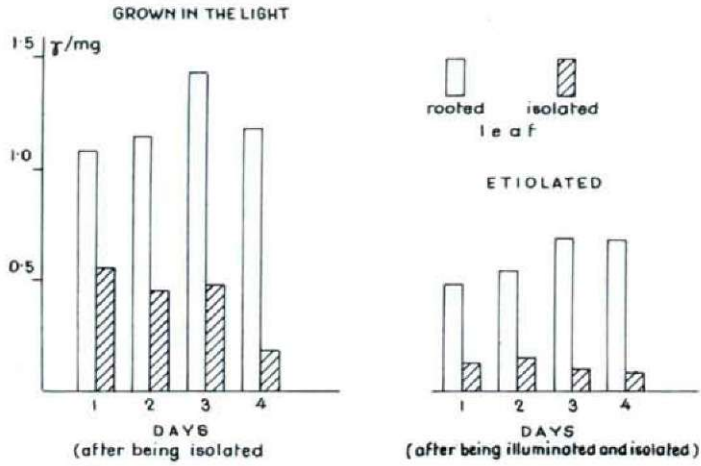
The quantity of the pigment components of wheat seedlings is in correlation with the length of the daily illumination. According to WOLF's experiments (1964), chlorophyll-a and -b content reached its highest value at a 20-hour long photoperiod, but at a 22-, 24-hour illumination it slowly decreased. A lighting of shorter time (eight hours) changed the ratio of chlorophyll-a and -b. At an illumination of six hours, the quantity of chlorophyll decreased to 80 per cent. In etiolated plants, the ratio of the quantities of chlodophylls and carotenes changes rapidly on even a short lighting period. In addition to the quantitative increase of the chlorophyll components, the increase of protein content may also be demonstrated (SMITH, 1963; GODNEV, KAHNOVICS, 1961). The quantity of pigment components is influenced in various ways by the quality of light. In plants grown in red light the accumulation of green and later of yellow pigments is more pronounced. As a result of blue light, initially the accumulation of green pigments increases more parallel with it the protein-, total nitrogen- and ascorbic acid-content of leaves. The amount of chlorophyll-a and -b depends upon the quality and intensity of light. As a result of white light, chlorophyll-b nearly reaches the amount of chlorophyll-a, while irradiated with red and infrared, the level of chlorophyll-b falls comparatively behind the chlorophyll-a component. The increase of the amount of chlorophyll-b is stimulated by a short flash of light and strong light intensity (KAHNOVICS, 1963; AUGUSTINUSSEN, MADSEN, 1965).

The autumn wheat 1201 from Bánkút was grown etiolated and with light in an artificial plantgrowing device (HORVÁTH, LASZTITY, 1965). The experiment was performed with seven days old plants. With rooted control (etiolated and grown in light) we observed, taken as a function of time, the change after removing the root, the influence of red and blue foils and, at green plants, the effect of darkness on the pigment components. The pigment determinations were carried out according to the method of KOSKI (1951), improved by FRENCH (1960).

Experimental results and discussion

In the first leaf of an isolated wheat seedling grown in light the amount of pigments is after a time reduced, which is in connection with the protein

decomposition. After the root is removed, the hydrolysis of proteins takes place very rapidly, and parallel with this the amount of the chlorophyll-a pigment component decreases. In etiolated, isolated and intact wheat seedlings as a consequence of illumination the amount of chlorophyll increases for a time but later on it decreases rapidly. In rooted etiolated plants, as a result of the continuous illumination, chlorophyll-a and -b and carotene accumulate unhindered.



Graph 1. Change in the quantity of chlorophyl-a in case of an intact and isolated wheat seedling of 7 days (reconing γ/mg).

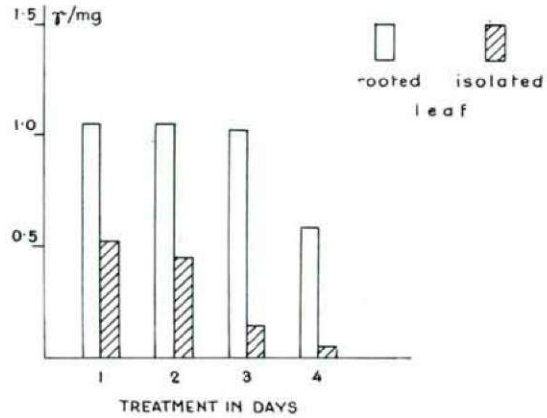
In graph 1 the change of chlorophyll-a is emphasized both in intact and isolated wheat seedlings grown in light and in rooted and isolated wheat seedlings exposed to an etiolated illumination. After removing the roots, from the pigment components chlorophyll-a is decreasing the most expressedly and, after being illuminated, this is the component which accumulates. In the detached leaves the decrease of the amount of chlorophyll-a shows some parallelism with the protein hydrolysis starting very quickly (HORVÁTH, LASZTITY, 1966; 1967).

As we put the isolated and intact wheat seedlings, grown in the light, into the dark, we saw at the rooted plants that they do not suffer a loss quickly while having a supply of nutriment, or carbohydrate. The etiolation of their leaves is much slower than that of detached ones. The latter ones perish very fast.

In graph 2 we stress the quantitative change of the chlorophyll-a component.

The graph shows that the chlorophyll-a content of the green rooted plants remains on the same level in the dark for three days and on the fourth day it decreases almost by half. In detached leaves, the effect even of a single dark day shows a decrease of about 50 per cent as compared to the rooted plants, and on the fourth day, the chlorophyll-a content can be demonstrated only in traces.

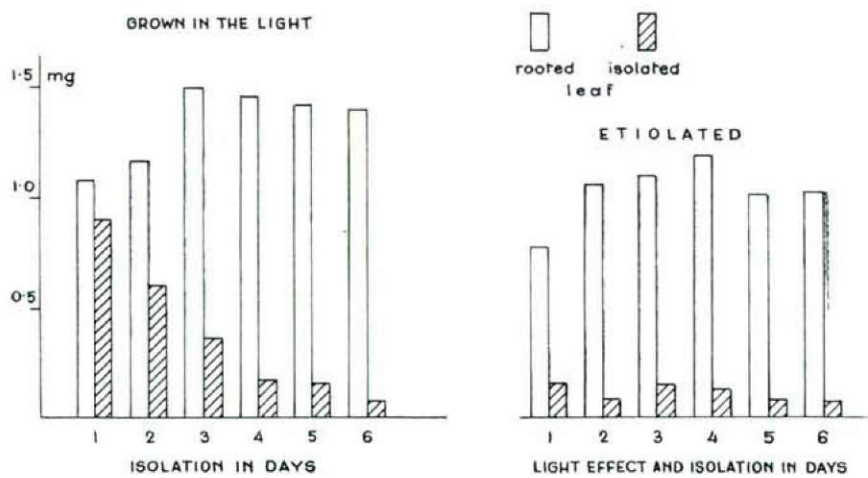
We have observed the change in pigment components of rooted and detached plants, grown in the light and etiolated, as a result of red and blue



Graph 2. Change in the chlorophyl-a content of an intact and isolated wheat seedling treated in the dark (Isolated on day 7, reckoning γ/mg).

foils, taken as a function of time. The covering with red foil caused an increase of the green pigment amount of rooted plants. The influence of red light was connected with a more intensive cell-division and pigment augmentation. The effect of blue foil is similar in case of yellow pigments. In the detached leaves, the destruction was similarly shown in the course of time. The change in chlorophyll-a is demonstrated in graph 3, as a result of red foils in rooted and detached wheat leaves, grown in the light and in etiolated rooted and detached ones.

In green rooted plants, the accumulation of chlorophyll-a can be observed while the growth of leaves by cell-division endures, and in the third day we



Graph 3. Effect of red foil on the change in chlorophyl-a of an intact and isolated wheat seedling. (Isolated on day 7, reckoning γ/mg).

obtain a very high value as a result of red light. Later on, the amount is comparatively decreased by the growth through lengthening. In the detached leaves, the decrease of chlorophyll-a component is starting more slowly, on the sixth day it hardly yields a measurable value.

In the etiolated rooted plants the accumulation of the chlorophyll-a amount is of similar rate but fewer nutrients being available than at the green rooted plants, it can be found in a smaller amount. In the detached etiolated leaves the destruction is very fast.

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Acta Biologica Szeged 17 (1—4), pp. 123—126 (1971)

CHANGE IN THE PEROXIDASE ENZYME ACTIVITY IN THE LEAVES OF WHEAT AND BARLEY SEEDLINGS

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(Received April 20, 1971)

Introduction

Peroxidase catalyes the oxidation of indolacetic acid as plant growth hormone and vice versa, the indolacetic acid changes the peroxidase activity in the plant tissues. Simultaneously with aging, the hormone supply grows weaker, making possible the appearance of a new isoenzyme in intact plants (Ockerse—Siegel—Galston, 1966).

It is indicated by preliminary investigations that after removing the roots of seedlings, in the detached leaves the activity of several enzymes grew higher, taken as a function of time, in this way that of peroxidase, as well (Kisbán, 1964).

In this paper we are investigating how the enzyme activity of peroxidase changes in the leaves of wheat and barley seedlings after removing the root, and as a result of various treatments.

Materials and Methods

The experiments were carried out with seven-day wheat seedlings „Bánkúti 1201" and „MFB" seedlings (hybrid barley of Martonvásár). The plants were grown under conditioned circumstances (Horváth—Lasztity, 1965). The root of seedlings grown in light and etiolated was removed on the seventh day. The detached leaves were placed into running tap water, the tap water solution of 10^{-2} M kinetin, the tap water solution of 0,02 M KCN. The etiolated leaves, together with the rooted controls, were placed in light, too.

Dikorint, the soda-salt of 2—4 dichlorophenoxiacetic acid was used in a 666 p. p. m. concentration.

The enzyme, after the seedlings had been derooted and treated, was measured, taken as a function of time, in 5 to 7 repetitions, according to the method of Solymossy—Farkas, 1963.

Discussion and evaluation of experimental results

We demonstrate in Fig. 1 the results of enzyme activity measured in the detached leaves of wheat seedlings and of rooted cotrol plants, taken as a function of time.

We have observed in the detached leaves in every case a higher peroxidase activity than in the rooted controls. On the injured surface the respiration is of higher degree. As a result of hydrogenperoxyde, being present in large quantities and accumulated owing to the extraordinary metabolism, the per-

oxidase enzyme shows a higher activity that may have been a consequence of allosteric stimulation, as well.

In Fig. 2 we sum up the enzyme activity measured in the leaves of etiolated isolated and intact wheat seedlings, taken as a function of time.

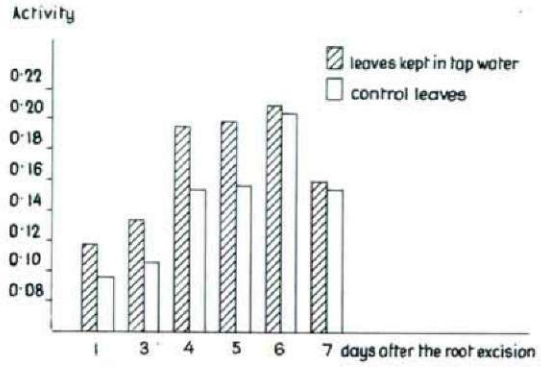

Fig. 1

It is obvious that after removing the root, the enzyme activity is already on the first day higher than it is in the rooted control. The difference continues till the seventh day. The decrease appearing on the seventh day, at both variants, already refers to a lack in nutrient supply.

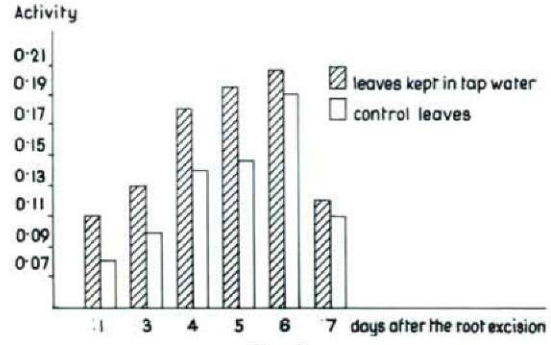

Fig. 2

In Fig. 3 we compare the enzyme activity of leaves kept in kinetin-, KCN-solution and in running tap water to the control, on the fourth day of treatment.

Aging is inhibited by kinetin for a time but the enzyme activity is increased as compared to the control. Aging is increased by KCN in detached leaves, the decay of living parts is obvious. This process is accompanied by an increased

H_2O_2 production; the enzyme activity showed therefore, here, the greatest intensity as compared to the other variants.

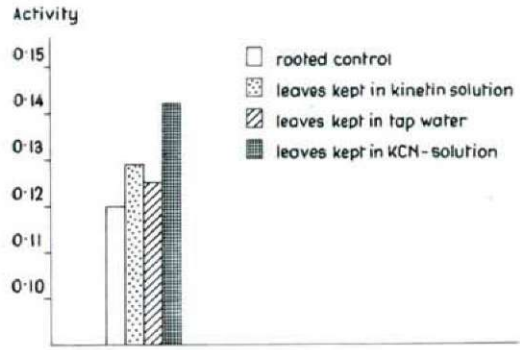

Fig. 3

In Fig. 4 it can be seen that as we grew the seedlings etiolated for seven days, then isolated the leaves and, together with the rooted plants, put them in light, the enzyme activity was increased in the rooted plants by the longer duration of the time of illumination. The detached leaves were in KCN-solution. The aging process of the detached leaves was accelerated very much by light and KCN; which was indicated by the strikingly high enzyme activity.

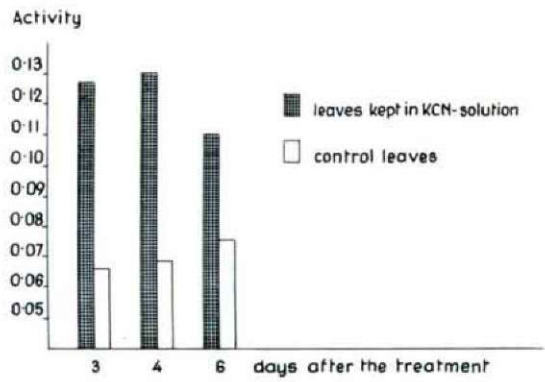

Fig. 4

It may be seen in Fig. 5 that Dikonirt, the soda-salt of 2—4 dichlorophenoxiacetic acid kept the enzyme activity on a high level, as compared to the control, for 1—8 days after germination. The applied very high Dikonirt concentration (666 p. p. m.) has induced a destructiv e change in the barley seedlings, obvious even phenotypically bringing about an aging in their metabolism.

Summing up our experimental results, it may be said, that both in the green leaves and in the etiolated ones, after the root system having been removed, the peroxidase enzyme activity increased, taken as a function of time. A similar activity increase was caused by 2—4 D. — KCN and light, applied jointly, have accelerated the process in etiolated leaves.

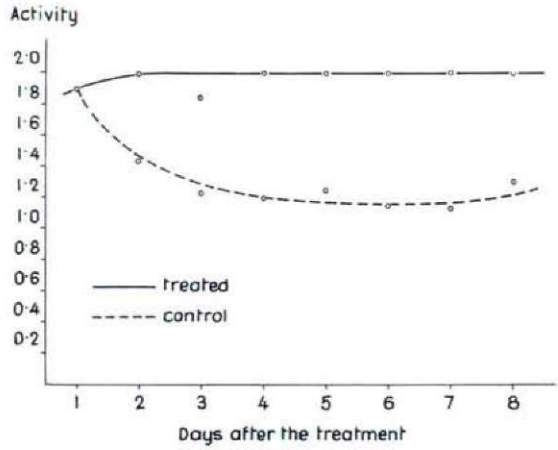

Fig. 5

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Acta Biologica Szeged 17 (1—4), pp. 127—129 (1971)

INVESTIGATION OF YELLOW CORN SEEDLINGS SELECTED ACCORDING TO THEIR ROOTS

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(Received April 25, 1971)

Introduction

One of the main determinants of the productivity of yellow corn is the rate of development of its roots. The duration of the active functioning of roots is determined by the properties of the species and by environmental factors. In the early period of the development of the plant, the seed roots and primary roots take part in the nutriment supply (BERKE, 1963). Investigating the seedlings, the observable differences give information on the physiological and cultural delimitation of a single species. It was established that there is a connection between the underground parts and those above the surface. The root system of yellow corn species of moderately late and late ripening is stronger. The formation of roots is influenced by the state of development of leaves (PORTSANKO, 1959). According to other authors the state of development of the primary and secondary seed roots of grain crops is not always in proportion with the parts above the earth surface. The part of the plant above the surface may be weakly developed, having nonetheless a strong root system, but the reversed case is also possible (MUSCIK, 1965). Comparative root phenomenological investigations were carried out in inbred yellow corn lines, with considerable differences between the isngle lines (ANDREW, 1966). We have earlier started our experiments with seedlings of inbred lines A 111 and Ia 153, selected according to their roots.

Materials and Methods

We have grown the three-day seedlings in hydroculture in light-thermostat. The investigations were performed on the sixth and tenth days. We have selected the six- and tenday old plants, according the length of their roots, into long, medium and short groups. We have obsorved the augmentation of dry-matter content in roots and leaves, as well as the formation of the amount of total pigment content (HORVÁTH, 1965) in leaves of the seedlings with long, medium and short roots.

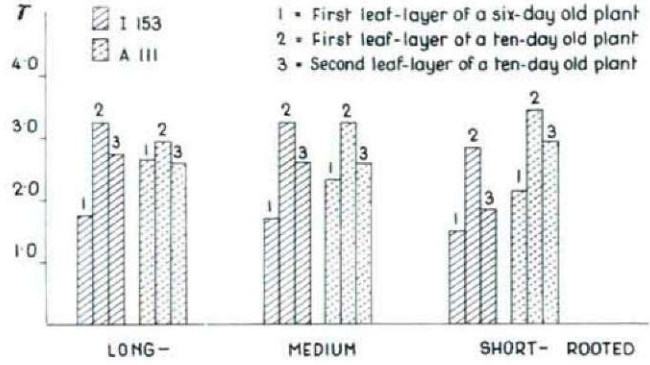
Evaluation and discussion of results

In the graph we demonstrate the development of the total pigment content in the six- and ten-day old seedlings of lines Ia 153 and A 111. In case of the six-day old seedlings of line Ia 153 in the short-rooted ones, the pigment is

somewhat less than in those with long and medium roots. At the ten-day old plants, in the leaves of the short-rooted ones the pigment is less than in the long- and medium types. It is in the second leaf of the short-rooted ones already considerebly less than in those with long and medium roots. Until the ten-day old age an increase can be observed in the pigment amount of all the three types.

In the six-day old short-rooted seedlings of line A 111 the pigment is less. In the ten-day old seedlings, in the first leaf the amount of pigment increases. And in the plants of line A 111 the augmentation is more intensive.

The pigment content of the first and second leaves shows an increase in both lines.



In Table 1 we demonstrate the formation of the dry-matter content of the two lines selected according to the root-length in the percentage of 1 g fresh weight. In both lines, the dry-matter accumulation in the first and second leaves is demonstrating the increase by cell-division and extension. The dry-matter content of the long, medium and short roots is lower than that of leaves. In the short roots the accumulation of dry matter is greater than in the case of both lines of the types with medium and long roots.

Table 1

Formation of the percentage of dry-matter content in the seedlings of lines I 153 and A 111

Lines	Age of the plants in days	Long-			Medium-			Short-rooted		
		Root	Leaf		Root	Leaf		Root	Leaf	
			1	2		1	2		1	2
I 153	6	7,17	10,68	—	8,28	11,13	—	8,38	11,18	—
	10	7,12	10,32	11,39	7,85	10,30	11,45	8,15	10,42	11,43
A 111	6	7,99	10,91	—	8,85	11,33	—	8,24	11,53	—
	10	7,19	10,32	11,14	7,68	10,22	10,94	8,01	10,41	11,37

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Acta Biologica Szeged 17 (1—4), pp. 131—141 (1971)

DATA TO THE KNOWLEDGE OF SUBMUCOUS GLAND CELLS OF THE AVIAN PROVENTRICULUS

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(Received May 31st 1970)

Among the anatomical peculiarities of the avian digestive system the structure of the stomach is the most conspicuous one, having two well separable parts i. e. the glandular stomach (proventriculus) and the muscular stomach (ventriculus). The main task of proventriculus is to produce gastric juice while that of ventriculus is to grind the food. Consequently, their histological structure is particular.

In this paper we wish to deal with the light and electron microscopic structure of secreting cells of the compound gland in the tunica submucosa of the porventriculus.

Materials and Methods

Our observations were performed on the ventriculus partly on granivorous species (Balcanic laugher dove: *Streptopelia decaocto* FRIV.; domestic pigeon: *Columba domestica* L.) partly on raptorial species (black-headed gull: *Larus ridibundus* L.; peewit: *Vanellus vanellus* L.).

For the histological examination the freshly dissected material was elaborated in two ways. Partly it was fixed in Bouin's and Carnoy's fixing mixture, then after having been dehydrated and embedded in paraffin, the section series were stained with haematein-eosin, methylgreen-pyronin and toluidineblue-floxine.

Partly, for investigating it with electron microscope, we embedded the dehydrated material — fixed in 1 p. c. OsO_4 buffered according to MILLONIG (1962) — into araldit. Contrasting it in the block, we used 3—4 p.c. uranyl-acetate, at sections according to REYNOLDS's (1963) procedure. The sections were prepared with an ultramicrotome Tesla BS 478, the photographs with a table electron microscope Tesla BS 242 D.

Apart from studying paraffin-embedded and ultrathin sections, we made semi-thin preparations, as well, staining them according to RÜDEBERG (1967) with metilineblue-tionine.

Results

The most characteristic feature of the histological structure of fowl proventriculus is the compound tubular gland, filling in the tunica submucosa nearly in its full thickness, whose structural composition corresponds to that of glands of similar type. The cells performing section are cubic while those forming the wall of the efferent canals are cubic initially but in the main efferent canal they turn into pyramidal epithelia (Table I, Fig. 1).

In the histologically stained paraffin sections, the secretory cells do not separate (Table I, Fig. 2). In the ultra-thin sections and in the semi-thin ones, investigated complementarily, two cell types can be distinguished („A" and „B") that may be separated clearly from each other and are showing some differences not only in their structures and staining but also in their position. The majority of cells forming the wall of the exocrine gland tubules are type „A". Wedged in them, near outer wall of the tubule we find type „B" cells (Table II).

The characteristic of „A" cells is a strong interdigitation (Table III, Fig. 1, 3) that can be observed only scarcely when coming into contact with the cells of type „B" (Table V). At the base of cell, the membrane protrusions create a complicated system whose average thickness is 2600 Å (Table III, Fig. 3). The part of mebrane near the lumen is smooth in a state of rest; in active cells, however, it is rich in microvilli.

From the cytoplasmatic organella of „A" cells, the number and size of mitochondria, the orientation of mitochondria and of the granulated endoplasmatic reticulum deserve attention. The average size of mitochondria found in the cells in large numbers is 1—1.5 μ. They can be observed particularly densely in the basal part of the cell and the very same area is covered with the densest network of the granulated endoplasmatic reticulum, as well (Table III, Figs. 1, 3). Often, even the nucleus of cell is enclosed by a mitochondrial ring. The endoplasmatic reticulum surrounds in a characteristic way almost every mitochondrium with a densely granulated canal (Table III, Fig. 3). The apical part of cell is poorer in granulated endoplasmatic reticulum, beside it we can observed the enrichment in vacuola with an average diameter of 0,16 μ (Table III. Fig. 2).

Cells „B" fall very short both in number and in size of those of type „A" (Tables II, IV, V, VI). These cells are situated in the basal membranes of the gland tubule and their apical part never reaches the lumen of tubule. It shows differences from the previous type that are important in ultrastructural respect,

ABBREVATIONS

A	— cell type „A"	L	— lipid granule
B	— cell type „B"	Lu	— lumen of the secreting canal
BM	— basement membrane	M	— mitochondrium
C	— capillary	N	— nucleus
CT	— connective tissue	NL	— nucleolus
End	— endothelial cell	R	— ribosoma
GER	— granulated endoplasmic reticulum	RBC	— red blood cell
Go	— Golgi apparate	SER	— smooth endoplasmic reticulum

Table I

Fig 1. *Larus ridibundus:* proventriculus Sectional drawing of submucosa glands. The cells of outlet and the secretion (arrows) are strongly stained. Toluidineblue-floxine staining. x 315.

Fig. 2. *Larus ridibundus:* proventriculus. The cells forming the wall of secretory tubules are equally stained. Toluidineblue-floxine staining. x 1200.

Table II

Columba domestica: A detail of the submucosa gland of proventriculus. Semi-thin section, methylineblue-thionine staining, light microscope photograph. The wall of gland tubules inconstructed mainly of cells of type „A" wedged between them some cells of type „B". Among the gland tubules several blood vessels can be observed. x 1700.

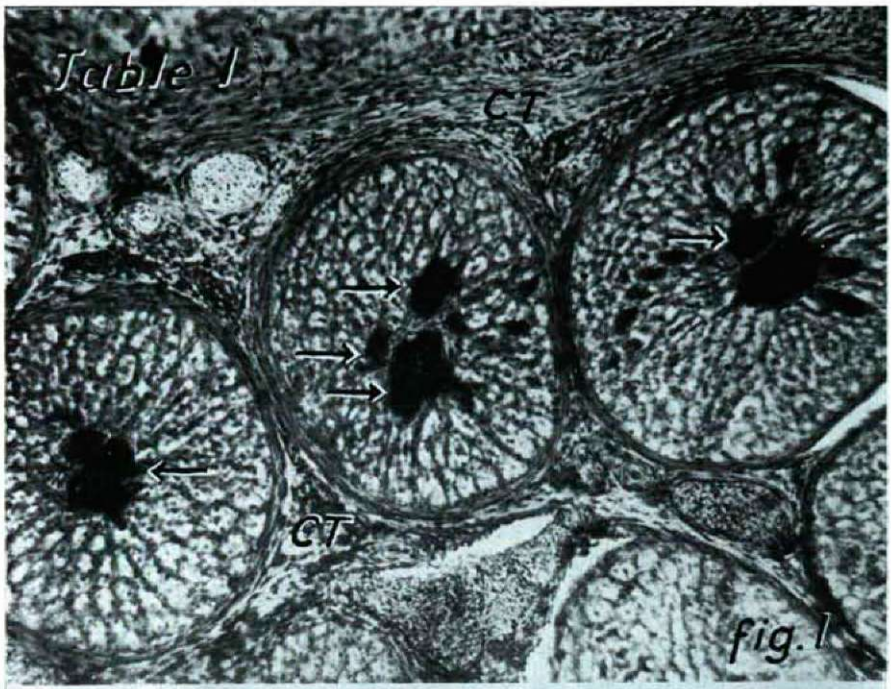
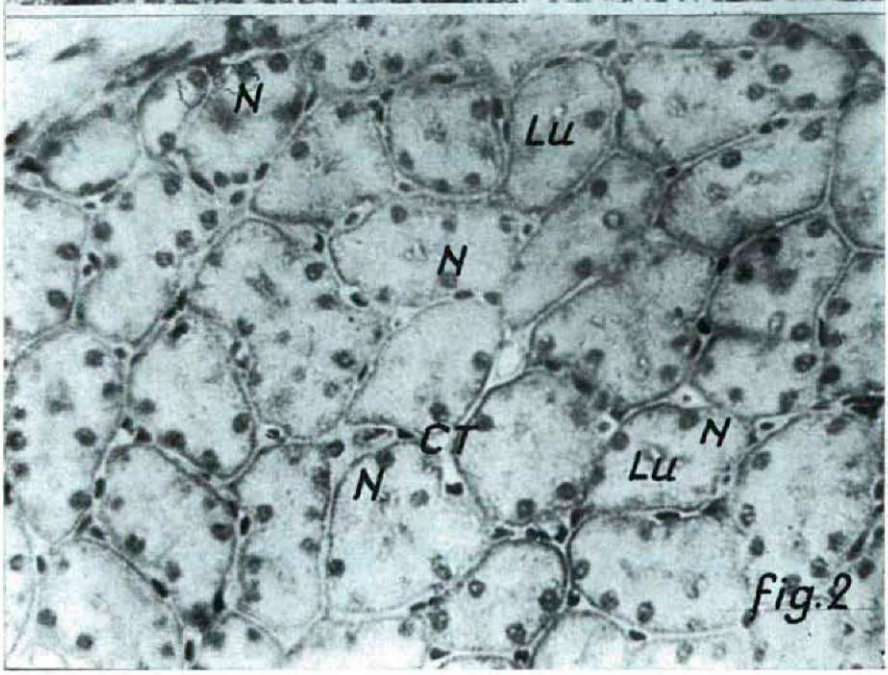


Table I
CT
CT
fig. 1


N
Lu
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CT
N
N
Lu
fig. 2

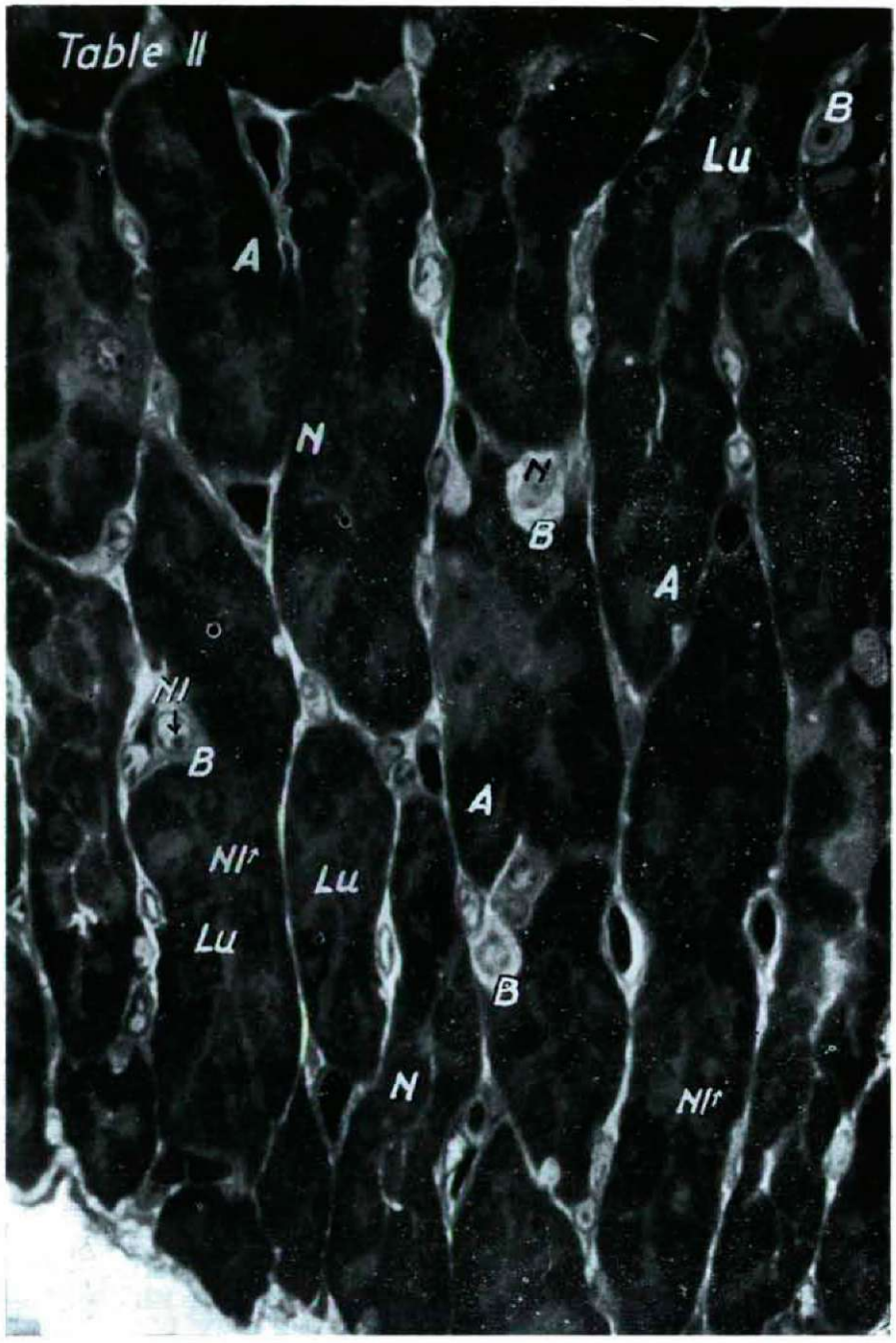
Table II
B
Lu
A
N
N
B
A
Nl
B
A
Nl
Lu
Lu
B
N
Nl

too. A characteristic of their membranes is the absence or deficient development of interdigitation. The tiny cell is filled almost fully by the centrally situated nucleus giving — contrary to the previous cells — a considerable part of the mass of cell (Tables II, IV, VI). In the narrow cytoplasm border surrounding the nucleus of the cell there are but few mitochondria and little granulated endoplasmatic reticulum — contrary to cells of type „A". At the same time, Golgi apparatus is more developed and there can frequently be observed granula of various density and size, varying between 700—2400 Å (Tables V, VI).

Discussion of results

Literary date concerning the gland cells of the submucosa of proventriculus are comprising the discussion of cell structure and function. The researchers have established that these cells have in their structure the attributes both of the parietal and of the main cells of the mammalian stomach (HALLY, 1959; VASSALLO, SOLCIA and CAPELLA, 1969). Similar conclusions were obtained also by others during studying the gland cells of frog stomach (VIAL and ORREGO, 1960; SEDAR, 1961a; 1961b), inferences were drawn that these cells were equally capable of producing acid and zymogen-like matter (BATT, 1924; AITKEN, 1958; TONER, 1963a; 1963b).

A part of the literary data attribute a double function to these cells although the degree of importance is as yet unsettled. Accordingly, BATT (1924) and AITKEN (1958) emphasise the production of acid, while VONK, BRINK and POSTINA (1949) give account of their observations about acid production taking place not so much in the proventriculus but rather in the ventriculus.

On the basis of our investigations we can establish that the submucous glands of the proventriculus are built up by two cell types. These cells have

Table III

Fig. 1. Electron microscopic picture of a cell of type „A". The cell is lying on a basel membrane, surrounded wholly by a complicated system of protrusions (arrows) forming an interdigitative connection with the adjacent cells of type „A" (double arrows). The nucleus is situated basally. Mitochondria appear in high numbers primarily close to the basal membrane and round the nucleus. The endoplasmatic reticulum is conspicuously rich; there are several free ribosoma and those attached to membranes. x 11 700

Fig. 2. Part of a cell of type „A" from the lumen. The cytoplasm is filled mainly with smooth endoplasmatic vesicles (arrows) and, in addition, with those of granulated surface (double arrows). Free ribosoma can be observed sporadically. x 32 800

Fig. 3. Basal part of a cell of type „A". A rich network of cytoplasm protrusions rests on the basal membrane (arrow). Mitochondria are characteristically surrounded by the canals of the granulated endoplasmatic reticulum, and the bulk of ribosoma is connected with it. x 16 800

Table IV

Picture of a cell of type „B". The cell is resting on the basal membrane; a further area of its surface is adjacent to a cell of type „A". Its cytomembrane is smooth, its nucleus is comparatively large. The cell is poorer in mitochondria, and these are smaller, too, than those in type „A". x 51 000

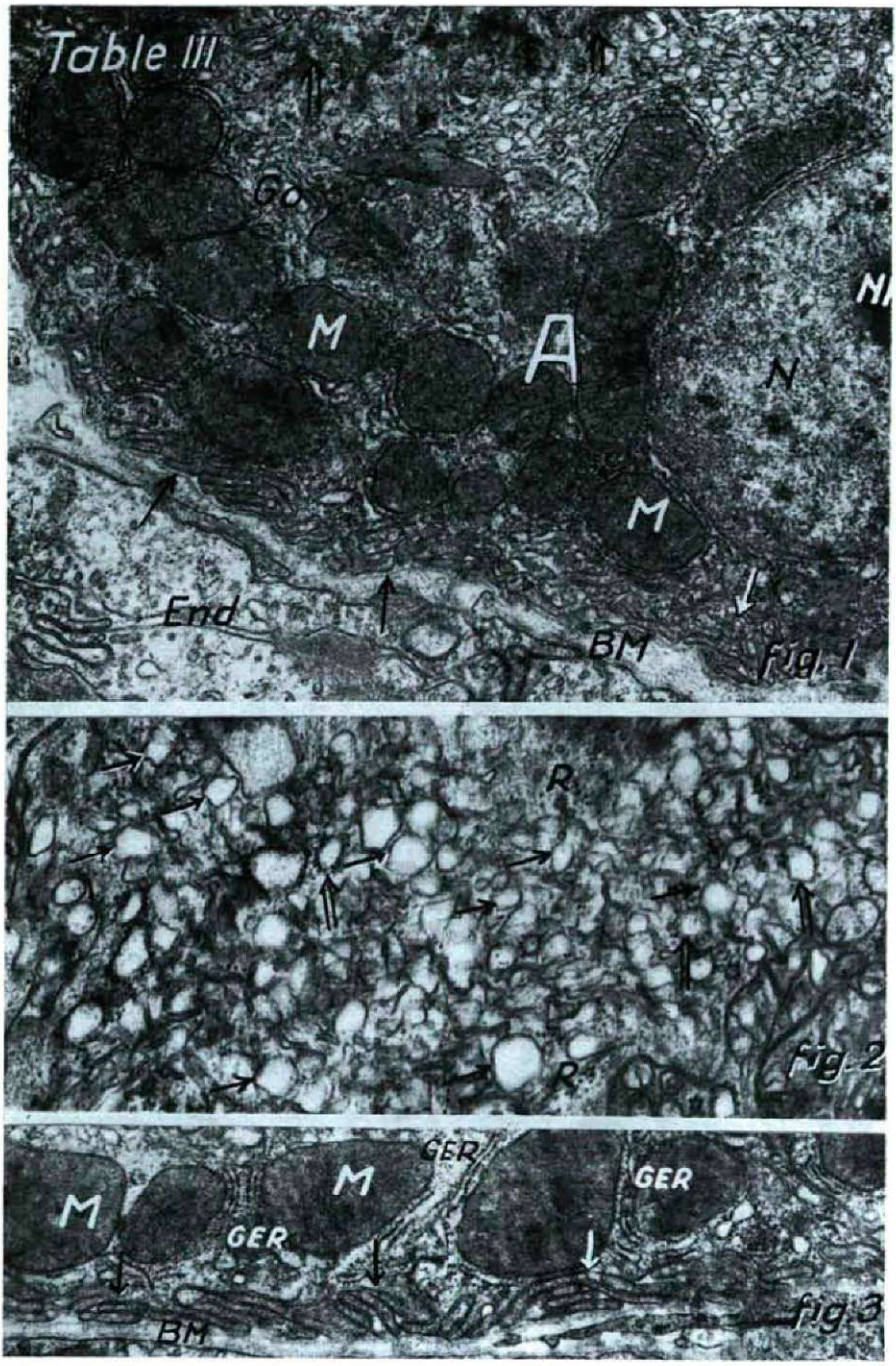
Table III
Go
M
A
N
M
End
BM
Fig. 1
R
R
Fig. 2
M
GER
M
GER
GER
BM
fig. 3


Table IV
A
M
M
GER
R
Go
B
R
N
M
GER
Д
BM

a structure that is similar to that of the secretory cells of tunic mucosa in the mammalian stomach as stated by other authors, as well (BATT, 1924; AITKEN, 1958; TONER, 1963a; 1963b).

Summary

The proventriculus of birds of various nutrition has been investigated with the morphological methods of light and electron microscope. It was established that the gland cells of submucosa can be divided structurally into two groups: one marked with „A", which are similar to the parietal cells of the mammalian stomach, the other with „B" corresponding to the main cells of the mammalian stomach.

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Table V

Picture of a secreting cell of type „B". Apart from the Golgi-apparatus and a few canals of the granulated endoplasmatic reticulum, secretion drops of various density of a size similar to, or somewhat smaller than, that of mitochondria are seen (double arrow). Cell „B" touches an „A" cell on the right, while on the left, it is separated by the narrow strip of the basal membrane from a cell having a very thin cytoplasm (asterisk) supposedly a fibrocyte. x20 000

Table VI

Figs. 1, 2. Secreting cells of type „B". In some places, the cytoplasm of „B" cells performs interdigitation with a cell of type „A" (VI/1, arrows). The density of secretion is inversely proportional to their size (double arrows), i. e., inspissate. x 28 000


Table V
M
B
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BM
GER
M
A
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L
N
GER
*
B
M
Go
Go
N
M
BM

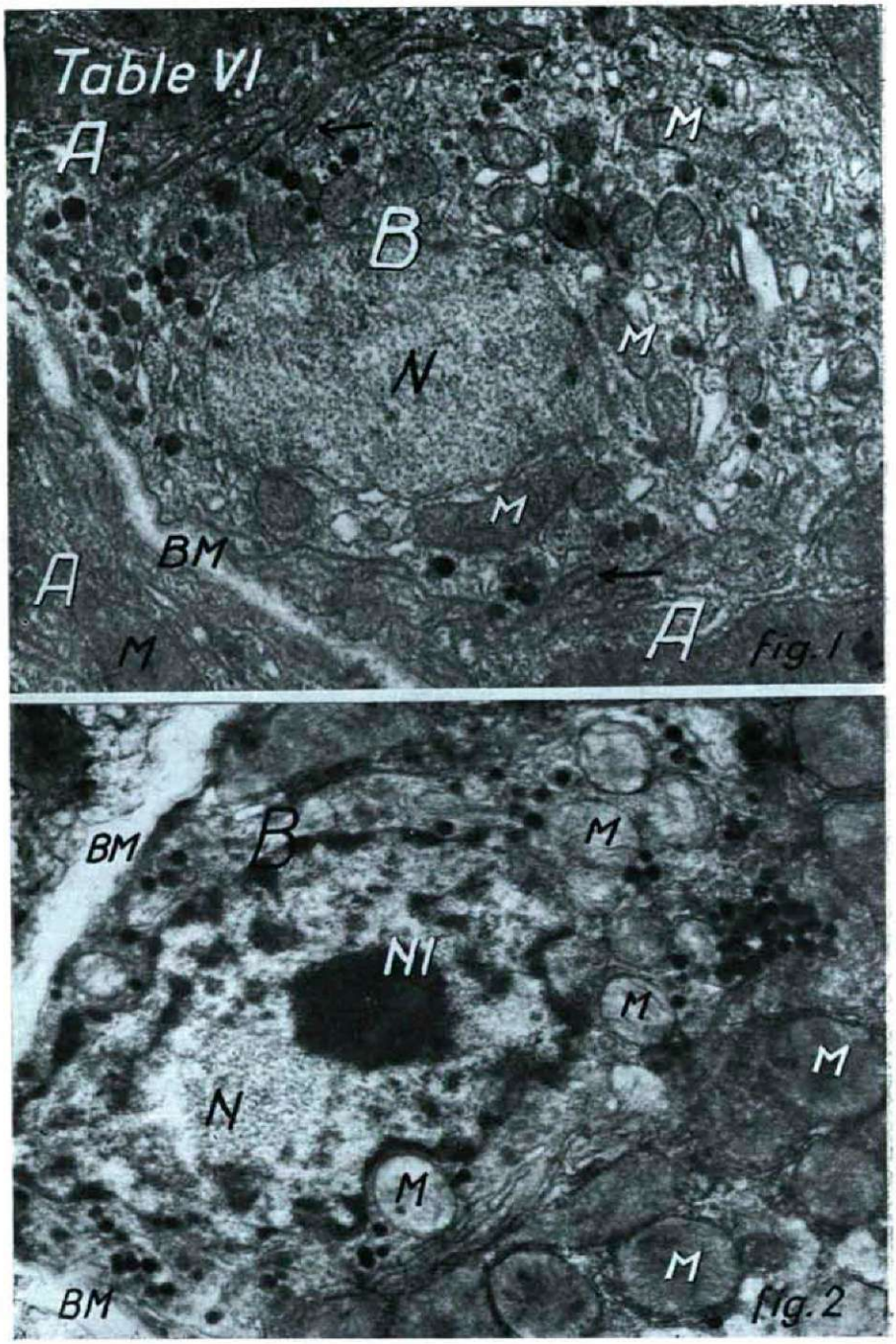
Table VI
A
B
M
N
M
M
BM
A
M
A
fig. 1
BM
B
M
N1
M
M
N
M
M
BM
fig. 2

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Acta Biologica Szeged 17 (1—4), pp. 143—152 (1971)

CONTRIBUTION TO THE PROBLEM OF THE SPECIFICITY OF THE ZIO IMPREGNATION*

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(Received July 21, 1970)

Introduction

As the results of the ultrastructural investigations accepted almost universally, in the later years evermore perfect varieties of the electron microscopic methods of fixation, embedding and impregnation have been elaborated. Nevertheless, as compared with the number of visualizing procedures tried and found suitable for light microscopes, there are comparably few methods adapted to electron microscopic examinations. Some fundamental methods (OsO_4, $KMnO_4$, aldehydes, negative ways of staining, etc.) are suitable for fixing all the components of the animal and plant tissues and cells recognized so far with a by and large unequivocal result. In the later decades electron histochemistry became a wide-spread way of investigation in order to reveal the chemical structure of the components of cells. Having recognized many components of tissues and cells fundamentally, the importance of histochemistry is recently growing for the methods often enable us to study the structures biochemically, enzymatically, pharmacologically, etc.

The procedure of zinc iodide — osmium tetroxide impregnation (ZIO) investigated by us is similarly of light microscopic origin (MAILLET, 1959; 1962; JABONERO, FABRA, MOYA and JABONERO, 1961; JABONERO, 1964; THIES, 1964; RODRIGUEZ-PÉREZ, 1964), applied lately also on electron microscopic level (AKERT and SANDRI, 1968; PELLEGRINO DE IRALDI and GUEUDET, 1968; 1969; MARTIN, BARLOW and MIRALTO, 1969; NIEBAUER, KRAWCZYK, KIDD and WILGRAM, 1969; LAMPARTER, STEIGER, SANDRI and AKERT, 1969; KAWANA, AKERT and SANDRI, 1969).

Since the beginning of the application of ZIO impregnation, the researches have been interested in the problem, what is in fact, impregnated by ZIO, resp. in wich sense this method may be considered to be specific. The most literary data report only on ZIO impregnated nerve components (nerve fibers, synaptic vesicles), but there are also results that have not supported this kind of specificity of the reaction. In our present work we want to make known our results obtained in various nerve structures concerning the specificity of ZIO impregnation.

* This investigation was performed while the Electron Microscope Laboratory was in the framework of the Faculty of Sciences, Attila József University, Szeged.

Plate I

Light microscopic picture of a rat iris after ZIO impregnation for five hours. The arrows point to the varicosities of the nerve fibers. (x 520)

Materials and Methods

For determining the specificity of ZIO reaction we have performed structural investigations on the corpus pineale and iris of full-grown rats, as well as on the superior cervical ganglion (SCG) of the cat. The investigations were carried out by impregnating with ZIO solution, prepared according to AKERT and SANDRI's (1968) method at a temperature of 0—4°C for different lengths of time (1, 2, 5 and 7 hours). The way of preparing the ZIO solution is as follows: the reaction of 7,5 p.c. Zn + 2,5 p.c. J_2 being realized in a wet medium, the solution obtained is mixed with the 2 p.c. diluted solution of OsO_4 in a ratio of 4 to 1, immediately before application. Here we note that in earlier investigations there were generally longer impregnations (16—20 hrs) applied and this method is followed by MADARÁSZ and co-workers, too, in the

Anatomical Institute of the University Medical School of Budapest during their similar investigations. The matter prepared for the electron microscopic study after the usual alcoholic dehydration was embedded in Araldit (PEASE, 1964). It was contrasted in block (during dehydration) with 3—4 p.c. uranyl acetate dissolved in 70 p.c. ethanol, then on the section according to REYNOLDS's (1963) method and our pictures were taken by electron microscope Tesla BS 242 D, as well as by Tesla BS 413. We have carried out light microscopic examinations on iris removed from rat in physiological NaCl solution and impregnated in ZIO for five hours.

Results

After impregnating the iris of the rat with ZIO — separating sharply from the adjacent elements of the connective tissue — we could reproduce light microscopically the staining of nerve fibers (Fig. 1). The nerve fibers run in bundles, in some places we could well observe the ZIO positivity of the so-called varixes in the nerve fibers, as in the case of silver impregnation. After a ZIO impregnation for 2 hours in the electron microscopic pictures of the corpus pineale of the rat, the electron-dense granules that demonstrated the site of ZIO positivity were found mainly in the vesicular regions of the nerves (Fig. 2). The average size of the ZIO-positive granules is 300—500 Å, often — but not always — localized in the wall or interior of the synaptic vesicles. Also in case of the two-hours impregnation we have observed the mitochondria being moderately swollen, supposedly owing to the low pH of the impregnating medium.

An impregnation lasting for a longer period of time considerably decreases the specificity of ZIO reaction and its elective axonal localization, changing even its granularity of usual size. In this case we often get reaction product of finer distribution of appearing in larged spots. After an impregnation of three hours, in the superior cervical ganglion of the cat the ZIO positivity has appeared, apart from the nerve fibers, on the nuclear membrane of Schwann cell, too (Fig. 3). Besides the granules, however, positivity also appears in spots, mainly cytoplasmatically. The size of ZIO-granules that can sometimes be observed in the perinuclear sites, as well, approaches that of the granules which are connected with the clear synaptic vesicles. At the same time, activity may be observed in the axolemma and in the myelin sheath, as well, appearing in the form of minor clods and being expressed particularly on the internal lamellae (Fig. 4).

After being impregnated for seven hours, the reaction of the endoplasmatic reticulum in the ganglion is remarkable (Fig. 5). It is well discernible in photographs of higher magnification (Fig. 6) that the ZIO-granules that are situated in the cysternae of the endoplasmatic reticulum do not fill compactly the tubules but there are ZIO-reactive elementary units of about 80 Å in diameter surrounding non-reacting units that may sometimes have 300—400 Å diameters. We want to notice that earlier Csillik and KNYIHÁR (1968), studying the electron microscopic localization of AChE similarly in the ganglion of the cat, described inactive endoplasmatic units. On the basis of the similar morphological pictures, it can be imagined that the same endoplasmatic units were visualized with the ZIO impregation, as well. In these preparations of ours also the perinuclear ZIO positivity is strong, appearing on the membrane forming both walls of the cysterna and in the gap itself, too. Also some mitochondria got stained and there may be observed in the cytoplasm also a large number of ZIO-positive granules that cannot be localized in a structural element.

Discussion

Several literary data are available to evaluate the specificity of ZIO reaction. The method of impregnation used, after the original KJ—OsO_4 staining (CHAMPY, 1913) was modified, in the form of ZnJ_2—OsO_4 first on light microscopic level (MAILLET, 1959), proved to be suitable mainly for visualizing the nerve fibers and nerve terminals (MAILLET, 1959, 1962; JABONERO, FABRA, MOYA and JABONERO, 1961; JABONERO, 1964). JABONERO (1964) emphasises that he has not succeeded in staining the neurons of the superior cervical ganglion. RODRIGUEZ—PÉREZ (1964), however, seems to have already stained in his adrenal gland preparation not only pericellular plexuses but cytoplasm, as well. THIES (1964) showed the so-called dendrite cells and the melanocytes, too, with ZIO in the human skin.

After applying the ZIO impregnation electron microscopically, AKERT and SANDRI (1968) reveal nerve impregnations. Later PELLEGRINO DE IRALDI and GUEUDET (1968, 1969) discuss the ZIO positivity observed also in the layer of rods and cones in the photoreceptor cells in the retina of the rat. NIEBAUER, KRAWCZYK, KIDD and WILGRAM (1969) stained the granules of the epidermal LANGERHANS cells, GOLGI zone and the nuclear membrane at patiens suffering from the LETTERER-SIWE disease. Simultaneously with the above investigations, the question of the specificity of ZIO was also raised. MAILLET (1959, 1962) and, following him, NIEBAUER, KRAWCZYK, KIDD and WILGRAM consider to be probable that the lipid-like matters are stained. According to AKERT and SANDRI (1968) the cholinergic mechanism is supposedly indicated by ZIO positivity and, essentially, this supposition is supported also by the work of MARTIN, BARLOW and MIRALTO (1969), opposite to the more recent investigation of KAWANA, AKERT and SANDRI (1969). It is worth noticing that the dense-core vesicles do not take up the stain while reserpin inhibits the ZIO positivity of the nerve fibers (PELLEGRINO DE IRALDI and GUEUDET, 1968).

In our present investigations, with an impregnation lasting only for a short time, we have succeeded in showing electively ZIO positivity localized in the nerve fibers and mainly in the clear synaptic vesicles of the corpus pineale of the rat. With the help of that, apart from the impregnation of nerve fibers by a long-lasting staining, we have demonstrated the ZIO activity appearing in the ganglion cells of the superior cervical ganglion of the cat that presented

Abbreviations:

Ax	axon	N	nucleus
Coll	collagen	M	mitochondrium
Cy	cytoplasm	My	myelin
Er	endoplasmatic reticulum	Sch	Schwann cell

Plate II

Corpus pineale of the rat. In the dilated gap of the connective tissue that separates the pinealocytes from each other several nerve fibers can be observed. ZIO positivity can be found exclusively in the nerve fibers. (x 32 000)

Plate III

Superior cervical ganglion of the cat after ZIO impregnation for three hours. The ZIO positivity can be found in „aspecific" sites, too: in the perinuclear cysterna of Schwann cell, on the axolemma and, non-bound to structure elements in the cytoplasm (arrows). (x 40 000)

Plate II

Plate III

itself strongly in the perinuclear cysterna and in the endoplasmatic reticulum, and it could be observed also mitochondrially, as well as in the cytoplasm, too, sporadically. In the some place, also nuclear membrane and processes of Schwann cells gave a strong reaction, and also the lamellae of the myelinated nerve fibers showed themselves active.

As compared with the literary data we may summarize the results of our investigations so that the ZIO method stains not only the nerve fibers and synaptic vesicles specifically, but after an impregnation for a longer period of time, it stains, in addition to the above mentioned ones, also several other elements of cells and nerve fibers. At any rate, further investigations are needed for recognizing the similarity of the chemical structure wich equally results in the ZIO positivity of the structures of different functions.

* * *

Special thanks of the authors are due to Prof. Dr. B. CSILLIK, Director of the Anatomical Institute, University Medical School, Szeged, for having kindly granted the use of electron microscope Tesla BS 413.

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Plate IV

SCG of the cat, after ZIO impregnation for three hours. The ZIO-positive electron-dense precipitate is bound, besides the synaptic vesicles of the axons, to several structure elements (arrows). (x 40 000)

Plate V

A: Ganglion cell from a cat's SCG, after ZIO impregnation for seven hours. ZIO positivity can be observed freely in the perinuclear cysterna (arrows), the endoplasmatic reticulum of the ganglion cell, as well as in the cytoplasm (arrow marked with an asterisk). (x 21 000)
B: Picture of a SCG ganglion cell of the cat after ZIO impregnation for seven hours. The granules of ZIO positivity having, on the average, 80 Å diameter surround in some places non-reacting units of a size 300—350 Å (arrows). (x 130 000)

Plate IV

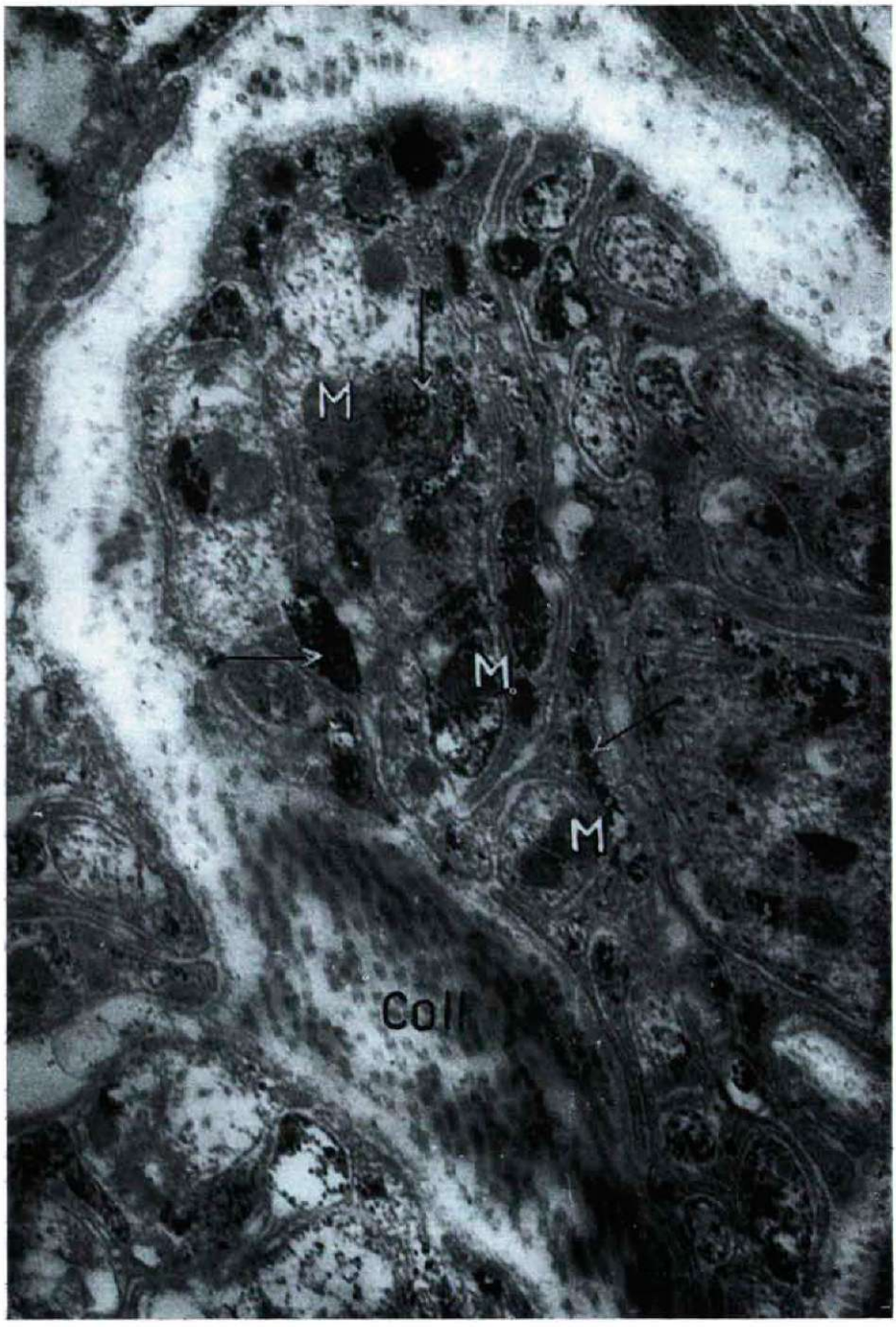
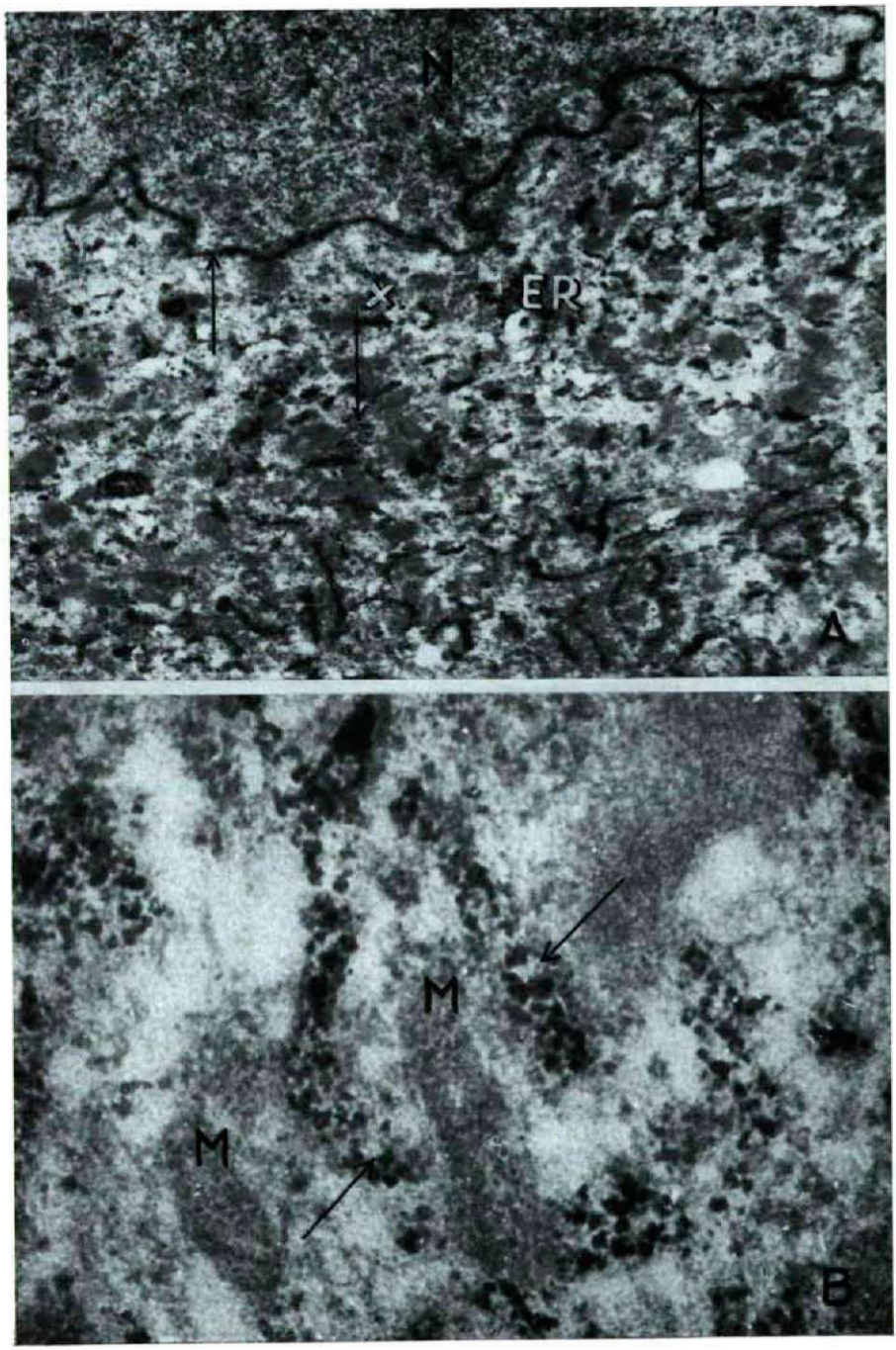


Plate V



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Acta Biologica Szeged 17 (1—4), pp. 153—158 (1971)

ZINC-IODIDE-OSMIUM IMPREGNATED CELLS IN THE PARAVERTEBRAL BUNDLE OF THE MARSH-FROG (RANA RIDIBUNDA PALL.)

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(Received December 1st, 1969)

In connection with the vesicles containing stimulation-transmitting materials there are several problems to be solved. According to certain investigators, the clear synaptic vesicles contain acetylcholine and amino acids (SJÖSTRAND, 1953; PALADE and PALAY, 1954; AKERT and SANDRI, 1968), and the dense-core vesicles catechol-amine and serotonin (DE ROBERTIS and PELLEGRINO DE IRALDI, 1961).

The separation of mediator material with monoamine content was completed by fluorescence histochemical investigations elaborated by FALCK (1962), ANGELAKOS and KING (1967). And the mediator materials of the synaptic vesicles of different forms (UCHIZONO, 1966) are connected with zinc-iodide-osmium impregnation (AKERT and SANDRI, 1968; MAILLET, 1962). With the latter method there was described the impregnation of other cell components, apart from the vesicles (JABONERO, 1964; PELLEGRINO DE IRALDI and GUEUDET, 1968; MADARÁSZ, 1969).

As in the paravertebral bundle and the adrenal gland of the marsh-frog I have found some cells similarly impregnated with zinc-iodide-osmium, I see some possibility to supply information about the function of the different kinds of paravertebral nerve cells.

Materials and Methods

The investigations have been carried out on eight full-grown specimens of marsh-frog (*Rana ridibunda* PALL.). I have treated a part of the paravertebral ganglia as well as the cells of adrenal glands, exposed from the animal anaesthetized with urethan and kept cold, with a mixture of CHAMPY-MAILLET's (1962) zinc-iodide-osmium mixture at 4°C for one and half hours. The other part of neurons and of the adrenal glands were fixed in BOUIN's and CARNOY's fixing mixtures, resp. in neutral formalin of 10 p.c. After dehydration, the 5—7 μ sections prepared from tissues embedded in paraffin were deparaffinized and then stained with MALLORY's mixture and with alkali tetrasolium modified by FINDLEY (KISZELY et al., 1958).

The ganglia used for the electron microscopic investigations have been fixed in a 1 p.c. osmium-tetroxide solution of pH 7,4 buffered according to MILLONIG (1961) on 4°C for one hour. The tissue pieces were treated with uranil-acetate and then embedded in araldit. The sections were cut with an ultramicrotome Tesla BS 478. The sections contrasted with lead-citrate have been investigated with an electron microscope of type Tesla BS 242 D.

Results

The vegetative nerve cells of frogs had been studied by several investigators (DOGIEL, 1882; SMIRNOW, 1890; KRAUSE, 1923; PICK, 1960, 1963; TAXI, 1965; HORVÁTH, 1966). Some problems still remained unsolved which is proved by our investigations carried out on the vegetative ganglia and the adrenal gland of the marsh-frog with a zinc-iodide-osmium (ZIO) impregnation.

Among the nerve cells some cells or minor groups of them occur, which stain darker or lighter, primarily in the ganglia of the abdominal part *(ggl. sympathicum* IV—VII; Table I, Fig. 1*)*, most of them being in the vicinity of the coeliac ganglion beside the intestinal artery after leaving the dorsal aorta (Table I, Fig. 2). The average size of the neurons is 5—15 μ, their 4—6 μ nucleus being mostly centrally situated.

I have observed the neurons of different staining and sizes both in the ganglia of younger and in those of older frogs. According to my supposition, the ZIO-positive neurons may be those containing in their cytoplasm electron-microscopically, too, more or less dense-core vesicles and osmiophilic granules of different sizes (Table II, Fig. 1). Besides them, in the larger neurons (25—35 μ) that form the majority of ganglia, we can only observe smaller or larger granules stained with ZIO.

I have observed also some of the chromaffine cells in the adrenal gland of frogs that are, concerning impregnation and size, similar to the ZIO-positive neurons of the vegetative ganglia (Table I, Figs. 3, 4). There, the greater number of cells contain purple-red formasane granules of large diameter with alkali tetrasolium. Apart from these cells, there could be observed also minor groups of round, projectionless cells of changing shape and painted paler, with black ZIO-impregnation (Table I, Fig. 4). These cells show, like those in the ganglia of the boundary bundle, acidic staining.

Discussion

CHAMPY-MAILLET's procedure of zinc-iodide-osmium impregnation had earlier been applied at light microscopic examinations and recently also at electron microscopic ones. JABONERO (1964) observed in the course of his light microscopic examinations that the pigments of the vegetative nerve cells of the paravertebral trunk in cat and rabbit, the GOLGI's apparatuses of very different kind of cells and the sensory neurons of the vagus nerve become black impregnated by ZIO. According to MADARÁSZ's (1969) electron microscopic examinations, only the material occurring inside the endoplasmatic reticular cisterns is stained by ZIO.

Table I

Fig. 1. ZIO-positive neurons of two sizes and two kinds of staining in Ggl. sympathicum VII. CHAMPY—MAILLET's procedure. x 600.

Fig. 2. A group of strongly stainable large nerve cells beside the intestinal artery. CHAMPY—MAILLET's procedure. x 600.

Fig. 3. Chromaffine cells of the adrenal gland stained with alkali tetrasolium. PEARSE's procedure modified by Findlay. x 300.

Fig. 4. ZIO-positive cells in the adrenal gland, stainable rather pale and rather dark. CHAMPY—MAILLET's procedure. x 300.

Table I

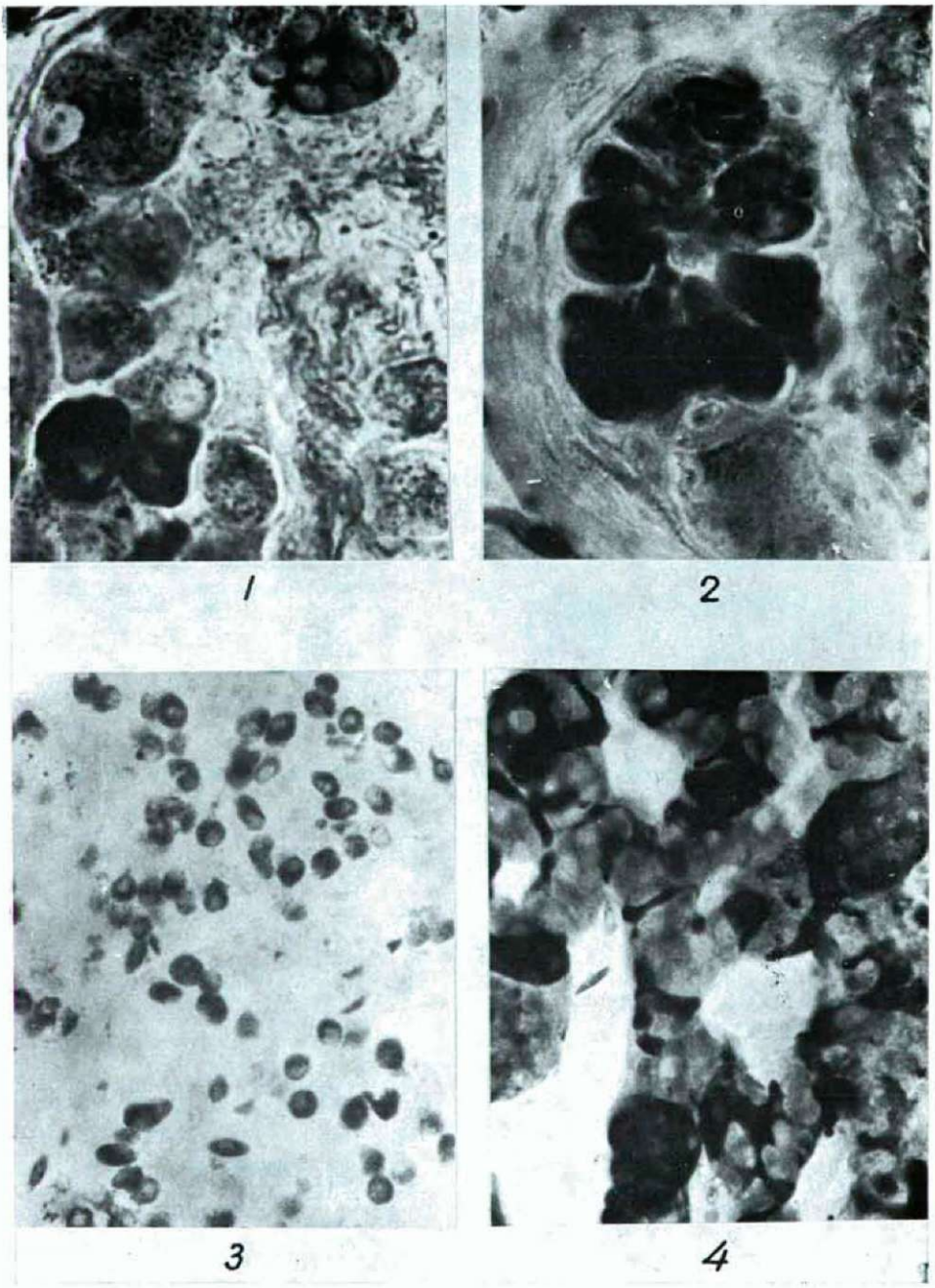
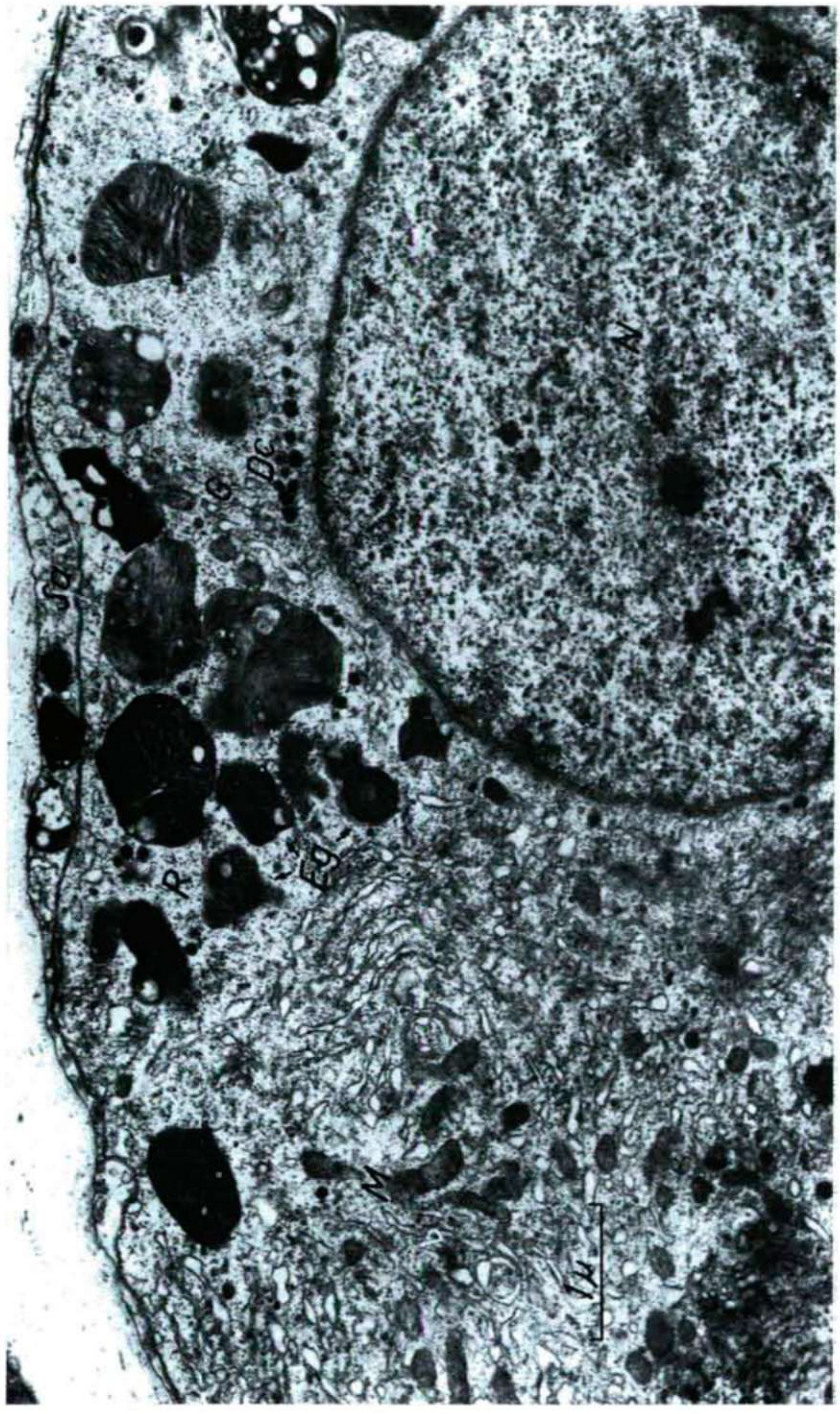


Table II



According to AKERT's and SANDRI's (1968) electron microscopic examinations, the ZIO-positivity of synaptic vesicules is connected with a cholinergic mediator material. HALÁSZ and co-workers (1969) have not observed any significant change in the ZIO-positivity of synaptic vesicles in the superior cervical ganglion of cat after treating the nerve-terminations with haemicholinium and stimulating exhaustively the preganglionic fibres. On the other hand, MADARÁSZ (1969) noticed that after being stimulated electrically the preganglionic fibres, the impregnation inside the synaptic vesicles ceased. In addition, it is worth mentioning, too, that according to an experimental result, owing to the effect of reserpine, both the granules of amine content (PELLEGRINO DE IRALDI et al., 1961, 1963) and the ZIO-positive material disappear in the vesicles. The same was observed after a treatment with chloroform-metanol, as well. Consequently it is supposed that some lipid components may be responsible for the reaction (PELLEGRINO DE IRALDI and GUEUDET, 1968).

According to the data cited, several structures are impregnated by ZIO. We cannot conclude, therefore, an identical function from cells stained identically. Comparing my results with the data in literature, I came to the conclusion that the ZIO-positive cells found in the vegetative ganglia and in the adrenal gland of the marsh-frog may cary out, however, in different sites, similar functions.

ERÄNKÖ (1960) could separate two cell types in the adrenal gland of the rat with fluorescence and other histochemical methods, and BENEDECZKY (1967) separated three cell types in the adrenal gland of the edible frog (*Rana esculenta* L.) with electron microscopic examinations.

I could find two kinds of cells in the paravertebral bundle. According to my opinion, the less numerous ZIO-positive cells are the sympathetic nerve cells, producing adrenalin. The majority of the nerve cells in the paravertebral bundle — showing in the cytoplasm small black granules with ZIO-imprenation under light microscope, and containing no dense-core vesicles in the electron microscopic pictures, beling to the parasympathetic system.

Summary

Among the nerve cells of paravertebral bundle there can be separated two cell types in the mars-frog with a zinc-iodide-osmium staining procedure. These cells show differences probably depending on their functional state. In our opinion, the less or more stained 5—10 μ sized nerve cells similar with adrenal cells, function according to the adrenergic mechanism and the 25—35 μ neurons according to the cholinergic one.

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Table II

Fig. 1. Dense-core vesicles in one of the neurons of Ggl. sympathicum VI. Dc: dense-core vesicle, G: GOLGI's apparatus, M: mitochondrium, R: ribosoma, Eg: electron-dense granules, N: nucleus, Sa: satellite cell: Araldit embedding. x 18 000.

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Acta Biologica Szeged 17 (1—4), pp. 159—166 (1971)

MOLLUSCA PERIODS IN THE SEDIMENTS OF THE HUNGARIAN PLEISTOCENE VI. THE LOWER PART OF THE MIDDLE ARID PERIOD IN THE BORING OF FELSŐSZENTIVÁN

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This paper is the sixth publication of a series published yearly since 1962 and elaborating the *Mollusca* material of the boring at Felsőszentiván in 1954. The boring is 77 m deep, carried out for scientific aim and with due thoroughness by Professor I. MIHÁLTZ, the then head of the Institute for Geology of the University in Szeged. Prof MIHÁLTZ prepared a detailed geological profile of the sedimentary complex and has personally dictated the data to the present author. The profile has been divided by the latter on the basis of the *Mollusca* fauna into periods and subperiods. The middle arid (IIIrd) period is characterized above of all by the absence of aquatic fauna, resp. by its great poverty. The period may be divided into 13 subperiods. The present paper is dealing with the four lower ones (subperiods III/10—13) including the part 36.2—44.2 m of the profile. The elaboration is following the method of the previous papers.

Subperiod III/10. 36.2—36.5 m

It is formed by a single 30 cm boring sample. The material is quicksand with some loess. It is distinctly limited by the high number of „*Mollusca* exemplars altogether" (411, opposite to 9 in the above adjacent sample and 19 in the below adjacent one. (The evaluation of its fauna is based on a comparison with that of the above adjacent loess. That loess is the lowest part of subperiod III/9, lying from 34.6 m to 36.2 m, consisting of eight 20 cm boring samples, and containing 298 *Mollusca* exemplars altogether. Its detailed discussion was presented in the previous publication [HORVÁTH, A. (1966): The middle part of the middle arid period in the boring of Felsőszentiván. — Acta Biol. Szeged, 12, 149—158].

The aquatic fauna in subperiod III/10 is only represented by 1 single exemplar of *Anisus planorbis,* while in the adjacent loess it was represented by 1 exemplar of *Bithynia leachi.*

The number of exemplars of the amphibian *Succinea oblonga* (14) is moderate, but, compared to that in loess (together 19 exemplars, with 0—5 exemplars per sample), it has considerably increased and indicates more humidity.

The hygrophilic ubiquitous species (10 species, 387 exemplars) represent the bulk of the fauna. The number of species is two more than in loess, this increase being, however, only 1 exemplar of *Vertigo pygmaea* and 1 of *Vallonia enniensis.* They are fairly cold-resistant but also somewhat xerophilous species, their appearance suggests warmer weather. The other eight species are common with those in loess, but their numerical ratio differs considerably in the two layers.

Vallonia costata has the most exemplars (93), it is a fairly cold resistant and rather xerophilic species. The number of its exemplars is 15 in loess and 0—5 per sample, being there quantitatively on the fourth place. *Punctum pygmaeum* (79) is the second one, in loess — with 14 exemplars and 0—5 exemplars per sample — it is on the sixth place. Its natural increase is motivated by more humidity an dircher vegetation. *Cochlicopa lubrica* (66) is the third species that multiplied also as humidity increased. (In loess 2—21 per sample, altogether 88). *Trichia hispida* (48) is here the fourth, in loess (98, but 4—31 per sample), however, it takes the first place. It is a typical loess mollusc, tolerating the arid cold loess-forming climate better than the other species, multiplying more intensely as a result of increased humidity and warmth. *Euconulus trochiformis* (37) and *Vallonia pulchella* (36) are cold resistant but rather hygrophilic species. In loess, mainly owing to aridity, each of them is represented only by 3 exemplars altogether and so they take the last place. *Pupilla muscorum* (23) is the seventh, it lived nonetheless under more favourable conditions than in loess where it took the third place with 33 exemplars altogether and 0—9 exemplars per sample. It is a good cold-resistant species, satisfied with little humidity, but with the increase of humidity it got under more favourable conditions. *Deroceras agreste* (3) lived both here and in loess, too (15, 0—5 per sample). aproximately under equally unfavourable conditions.

The inhabitants of the groves are represented in this 30 cm layer by four species and nine exemplars, while in the 160 cm loess layer we have found only three species and eight exemplars of them. The *Perpolita hammonis* (3) occurs in four of the eight loess samples, each with 1 exemplar, and *Arianta arbustorum* (3), in loess similarly with three exemplars but only in a single sample. *Goniodiscus ruderatus* (2) and *Perforatella bidens* (1) could not be found in loess. On the other hand, *Columella edentula* subsp. *columella* was only found in loess, in a single exemplar. The subspecies is a subalpine form above the timber-line, from a colder loess climate. The presence of the grove-dwelling fauna occurring rarely both here and in loess, suggests, however, more humidity and a richer vegetation.

No xerophilous species have been found here. Even in loess only one exemplar of *Imparietula tridens* was found. The species may have got more sunshine in the colder but more arid loess-forming climate, permitting it to survive.

The molluscs discussed here in detail remind us of the moist clearings of the Hungarian mountains of medium height. The above mentioned data suggest a cool humid climate, milder and more humid than that of the loess-forming period, and colder than the present climate of the Great Hungarian Plain. The vegetation may have been richer than that of the loess period but, as a matter of fact, it must have been rather open.

Subperiod III/11. 36.5—37.5 m

The layer is 1 m thick, consisting of two samples of 30 cm and two of 20 cm each. Its material is fine sand containing a little humus and loess. It is distinctly limited from the adjacent subperiods by the low values of *Mollusca* exemplars altogether (19—47) both upwards (411) and downwards (155—615). In the subperiod 137 exemplars were found, with no aquatic species at all.

From the two amphibian species *Succinea oblonga* (14) occurs in every sample but with a much lower number of exemplars than those observed is subperiod III/10, indicated much less humidity. The highly hygrophilic *Succinea putris,* found only in the third sample and only with two exemplars, may refer to the periodic presence of water.

The hygrophilic ubiquists are represented by eight species and 103 exemplars. The fauna adjacent above, continues in them with a much lower number of exemplars. Their population reminds us rather of the loess of subperiod III/9. Similarities to the loess fauna: absence of *Vertigo pygmaea* and *Vallonia enniensis,* the low number of exemplars, the first place of *Trichia hispida* (66) and the second one of *Cochlicopa lubrica* (20). The exemplar number of the other six species is much lower: *Vallonia costata* 6, *Pupilla muscorum* 5, *Vallonia pulchella* 2, *Punctum pygmaeum* 2, *Euconulus trochiformis* 1, *Deroceras agreste* 1. These data suggest an arid cold climate reminding of loess and an open vegetation. The grove-dwellers are represented by three species and thirteen exemplars. This fauna reminds us of the previous subperiod, being anyway somewhat poorer than that. *Perforatella bidens* is missing. I have found only one exemplar of it in the previous subperiod. And it may be not a matter of mere chance that just this most thermophilic species is absent. The other species are the same as those in the previous subperiod, their exemplar number is equally low *(Perpolita hammonis* 6, *Arianta arbustorum* 5, *Goniodiscus ruderatus* 2), and their occurence became sporadic. After all, the grovedwellers also indicate a more arid and colder climate than that of the previous subperiod.

I have found thermophilic species only in the two lower samples where they are represented by five exemplars of *Helicella hungarica.* The cool, humid milieu of the previous subperiod was unfavourable for the thermophilic species, and I have actually found none of them. Here, however, in a more arid colder climate that had anyway more sunshine, at least when the effect of cold was more moderate they managed to survive.

After all, this subperiod was much more arid and colder than the previous one, and had a poorer vegetation. The two lower boring samples came from a somewhat milder climate, as proved not only by the presence of thermophilic species, but also by the increase in fauna appearing with a general character.

Subperiod III/12. 37.5—40 m

The layer is 2.5 m thich and consists of five 50 cm boring samples. Its material is from 37.5 m to 38 m loess with some humus, lower fine sand with some loess containing a little humus between 38—39 m. It is distinctly delimited both upwards and downwards by the high values of *Mollusca* exemplars altogether. The samples are half m broad, i. e. larger than those of the previous subperiod, but upwards the difference continues to be very obvious, even if the exemplar numbers are decreasing proportionally. Downwards, in the next subperiod, the size of the samples remains 0.5 m. The total number of exemplars is 1757.

An aquatic species, namely four exemplars of Stagnicola palustris, could be found only in the upmost sample where it might indicate the periodical presence of stagnant water.

The amphibian species are the same as those in the previous period. *Succinea oblonga* (206) occurs here, too, in all the samples, but the number of its

exemplars is much higher, this means a more humid milieu and a warmer climate. *Succinea putris* (1) was found only in the first sample. It indicates the presence of water, since it lives only on the waterside.

The hygrophilous ubiquists, with 10 species and 1435 exemplars, constitute the bulk of the fauna here. The fauna augmented with the species *Vertigo pygmaea (11) and Vallonia enniensis* (4). These are somewhat thermophilous, their presence means more warmth. The other eight species are the same as those in the previous subperiod. Like in the previous subperiod, the first place is taken here too by the species *Trichia hispida* (931), the second one by *Cochlicopa lubrica* (184) but in an immensely increased number of exemplars. The other species are: *Vallonia pulchella* (89), *Pupilla muscorum* (76), *Punctum pygmaeum* (47), *Deroceras agreste* (47), *Euconulus trochiformis* (35), with equally superior exemplar numbers. All these numerical augmentations may be motivated by a more humid and milder environment. The amount of *Vallonia costata* (11) is also somewhat larger, although it was the third one in the quantitative order of the hygrophilous ubiquists of the previous subperiod and the ninth in this one. It is a good cold-resistant but also thermophilic species. Its multiplication here means a rise in temperature, remained, anyway, infavourable for the species.

The grove-dwellers are represented by four species and 88 exemplars. *Columella edentula* subsp. *columella* (1) did not occur in two previous subperiods. We have found it at last in the loess of subperiod III/9, where it occurred in two places with 1 exemplar in each of them. At present, this subspecies lives in the high mountains of Europe and in Northern Europe above the timber-line, indicating a far colder climate than prevails present by in the Hungarian Plain. The other three species are the same as these in the previous subperiod. *Arianta arbustorum* (45) is leading but its exemplar number is considerable only in the uppermost sample (29), in the other samples it appears systematically but only with low exemplar numbers (ranging from 2 to 7). *Perpolita hammonis* (37) is forming similarly a full sequence, its exemplary number varying between 1—10. In the three lower boring samples its quantity is larger that that of the previous species. *Goniodiscus ruderatus* (5) is everywhere rare but is missing only from one boring sample. After all, as compared to the previous subperiod, the occurrence of grove-dwellers is more systematic, and their amount has augmented, as well. This favourable change may be attributed to the effect of the more humid environment.

There are 2 species and 23 exemplars of thermophilic group. The more thermophilous *Helicella hungarica* (16) is restricted nearly entirely (with 15 exemplars) to the uppermost sample while the less thermophilous *Imparietula tridens* (7) occurs in the three lower samples. In the cool humid milieu of the subperiod the thermophilic group only vegetated. Their life conditions, however, embettered somewhat as compared to the previous subperiod, and this suggests a little increase in warmth.

After all, the milieu effect in the subperiod is cool and humid, much more humid and somewhat warmer, than in the previous subperiod. The vegetation increased but remained of open character. The uppermost sample of the subperiod may have originated in a somewhat milder climate, this may be concluded from the relatively high exemplar number of *Helicella hungarica* and *Arianta arbustorum.*

Subperiod III/13. 40—44.2 m

The layer is 4.2 m thick and consists of 9 boring samples, from which 7 are 50 cm, one is 30 cm and one 40 cm deep. Its material is quicksand, it is distinctly delimited both upwards and downwards by the lower amounts of „*Mollusca* exemplars altogether." Downwards the limit of the subperiod is common with that of the lower humid period (IV.) A clear-cut border line is drawn here by the quick augmentation of the aquatic fauna, as well. The number of exemplars found in the subperiod is 663 altogether, while 1757 were found in the much thinner layer of the previous subperiod. The aquatic fauna is represented only by three species and six exemplars: *Anisus planorbis* (3), *Stagnicola palustris* (2), *Anisus spirorbis* (1). These are ubiquitous species of a wide range of resistance. Aquatic species occur only in four of the nine samples of the subpeirod. Newertheless, the aquatic fauna is present throughout the whole subperiod with low exemplar numbers and incomplete. The waters may have been of seasonal character and, for motivating duly the low number of species and exemplars, low temperature of these waters is also presumable. These waters may have originated from the yielding of frozen soil and possibly from thawing of the snow.

The number of amphibian species is four. Two of them are common with the previous subperiod, while two others *(Carychium minimum, Succinea pfeifferi)* represent a surplus. The increase of species number may be attributed to the augmentation of water. Owing to more water we would expect an increase in the exemplar number, too, but we have experienced on the contrary, a decrease. The total number of exemplars is 171. *Succinea oblonga* (166) is the most numerous, constituting a full sequence, but its exemplar numbers are generally lower than in the previous subperiod. It is a characteristic loess mollusc but its cold-resistance is moderate, and in Northern Europe it is at present already scarce. Here it was influenced unfavourably by cold humidity. The quantity of the other three species is negligible. *Succinea putris* (3) and *Succinea pfeifferi* (1) are fairly cold-resistant, but they need a waterside. *Carychium minimum* (1) is equally cold-resistant, it is primarily a coastal species but in a humid environment it survives even far from water.

The hygrophilic ubiquitous species are represented by 10 species and 434 exemplars. The species are common with those in the previous subperiod, their exemplar number is, however, lower. (The category was represented in the much thinner layer of the previous subperiod by 1435 exemplars.) *Trichia hispida* (295) and *Cochlicopa lubrica* (53) maintain their leading on the first and second places, although with a strongly decreased exemplar number. *Pupilla muscorum* (28) has got, in regard to quantity, from the fourth to the third place but its exemplar number decreased also very much. The number of exemplars of the other seven species is low. They follow in this quantitative order: *Deroceras agreste* (14), *Punctum pygmaeum* (13), *Vallonia pulchella* (11), *Vallonia costata* (7), *Euconulus trochiformis* (7), *Vertigo pygmaea* (5), *Vallonia enniensis* (1). Unlike the previous subperiod, the decrease in the number of exemplars appears here in these species, too. The ubiquitous species mentioned in the paper prefer above all the humid coastal milieu, largely because of the richer vegetation. There was a shore here, nevertheless the fauna became poorer. This could be caused only by the cold that also prevented the coastal groves from developing.

The grove-dwellers are represented by four species and 35 exemplars. As compared to the four species and 88 exemplars found in the previous subperiod, this means a considerable decrease of the exemplar number. *Arianta arbustorum* (18) takes again the first place. It is fairly cold-resistant, In Northern Europe it survives even in the tundra. As concluded from its low exemplar number, here it may have vegetated under similar conditions. *Perpolita hammonis* (14) has maintained, although with a decreased exemplar number, its second place. Its cold-resistance is somewhat lower than that of the former species but it occurs beyond the timber-line in the tundra and in the Alps, as well. *Columella edentula* subsp. *columella* (2) occurs only in a single sample, being an evidence there of cold and open vegetation. *Clausilia dubia* (1) was not found in the previous subperiod. Its coldresistance is considerable but lower than that of the two previous species. It is a forest-dweller but occurs occasionally outside the forest, as well. In the Alps, is also found at altitudes about 2400 m. Here it is only a negligible element in the fauna, probably because of the cold and treeless milieu. *Goniodiscus ruderatus* is fully missing, although in the previous subperiod it occurred regularly except one sample. It is a good cold-resistant species but sensitive to much humidity and adheres to a woody environment. The cause of its absence here may have been much humidity and the open character of vegetation. After all, the qualitative and quantitative composition of the forest-dweller category in this subperiod seems to prove a cold, humid, treeless environment.

We have found two species and 17 exemplers of thermophilic snails. Certainly not by mere chance, they are represented almost exclusively by *Imparietula tridens* (16). Among the thermophilic species mentioned in this paper this species is the most resistant to cold and humidity. In the Alps it got up till 1000 m but does not live in Nonthern Europe any more. Its role is a subordinate, as it was in the previous subperiod. *Abida frumentum* (1) is somewhat more thermophilic and more sensitive to humidity and was missing from the previous subperiod, here too, I have found it only in the uppermost sample. *Helicella hungarica* that adheres the most to the warm arid environment still appeared sporadically in the previous subperiod but in this subperiod it couldn't be found any more. Solar radiation is much more effective at our latitude than in Northern Europe, therefore the thermophilic species had got enough light and warmth to survive. After all, subperiod III/13 was more humid and much colder than subperiod III/12. It was characterized by a much colder climate than the present one, by cold seasonal standing waters and an open vegetation. As far as the molluscs were concerned the most unfavourable period was during the formation of the layer 41—42.5 m. In these three samples, the thermophilic species together with several ubiquitous ones are missing, and also the grove-dwellers became rarer. This decline is shown by the amphibian Succinea oblonga only in the medial of the three samples, but at the same place we could find the aquatic *Anisus planorbis*, as well. The poor fauna of the three samples was caused, therefore, not by drought but by the increase of cold.

Stratigraphical chronology

In the previous publication I determined the time of loess formation on the bottom of subperiod III/9 from 34.6—36.2 m as a glacial continental part of $Riss_1$. This loess extends downwards till a dept of 40 m (bottom of subperiod

Astronomical chronology	Riss loceanic part										Mindel—Riss interglacial subarctic								
Stratigraphical chronology	Riss loceanic part										Mindel—Riss interglacial								
Mollusca subperiods	III/10	III/11				III/12					III/13								
Stratigraphical profile	Running sand with some loess	Fine sand	With some	Humus and	Loess	Loess with some humus	Fine sand with some	Humus and loess	Fine sand	With loess	Quicksand								
Species \ Depth m	36.2—36.5	36.5—36.8	36.8—37.—	37.—37.3	37.3—37.5	37.5—38.—	38.—38.5	38.5—39.—	39.—39.5	39.5—40.—	40.—40.5	40.5—41.—	41.—41.5	41.5—42.—	42.—42.5	42.5—43.—	43.—43.5	43.5—43.8	43.8—44.2
Stagnicola palustris O. F. MÜLL.						4	—										1		1
Anisus planorbis L.	1											1		1					1
Anisus spirorbis L.																	1		
Aquatic species altogether	1	—	—	—	—	4	—	—	—	—	—	1	—	1	—	—	2	—	2
Carychium minimum O. F. MÜLL.																	1		
Succinea putris L.				2						1		1						2	
Succinea oblonga DRAP.	14	1	4	3	6	23	5	86	27	65	10	12	13	2	14	27	24	15	49
Succinea pfeifferi RM.																			1
Amphibiotic species altogether	14	1	4	5	6	23	5	86	27	66	10	13	13	2	14	27	25	17	50
Cochlicopa lubrica O. F. MÜLL.	66	4	8		8	60	13	52	26	33	3	5			2	12	13	15	3
Vertigo pygmaea DRAP.	1							4	1	6	1					2	1	1	
Pupilla muscorum L.	23	1	2		2	6	5	42	10	13	4	3	1		3	6	7	3	1
Vallonia pulchella O. F. MÜLL.	36			1	1	7		38	15	29	4	2				2	3		
Vallonia enniensis GREDLER	1					3				1		1							
Vallonia costata O. F. MÜLL.	93	2	3	1		6		4		1	1			1			3	2	
Punctum pygmaeum DRAP.	79	1	1			25	1	16	2	3	2	1				2	6	2	
Euconulus trochiformis MONT.	37			1		4		16	4	11	1	2				1	2	1	
Deroceras agreste L.	3			1		4	1	16	10	16	4				1	1	5	3	
Trichia hispida L.	48	10	14	24	18	126	124	322	151	208	35	32	12	8	16	52	70	39	31
Hygrophilic ubiquist species altogether	387	18	28	28	29	241	144	510	219	321	55	46	13	9	22	78	110	66	35
Columella edentula DRAP.									1							2			
Clausilia dubia DRAP.												1							
Goniodiscus ruderatus STUD.	2		2			1	1	1		2									
Perpolita hammonis STRÖM	3		1		5	6	1	11	9	10	2	3	1			3	3	2	
Perforatella bidens CHEMN.	1																		
Arianta arbustorum L.	3			2	3	29	4	3	2	7		2	2	1		3	4	5	1
Inhabitants of the groves altogether	9	—	3	2	8	36	6	15	12	19	2	6	3	1	—	8	7	7	1
Abida frumentum DRAP.											1								
Imparietula tridens O. F. MÜLL.								3	1	3	7	1				4	2	1	1
Helicella hungarica SOÓS et H. WAGNER				1	4	15		1											
Thermophilic species altogether	—	—	—	1	4	15	—	4	1	3	8	1	—	—	—	4	2	1	1
Mollusca exemplars altogether	411	19	35	36	47	319	155	615	259	409	75	67	29	13	36	117	146	91	89

III/12) but it occurs only in a mixed state. Following the process of sediment formation upwards from below (in the chronological order of formation), we can establish the following: From 39 to 40 m the sediment is fine sand with some loess, delimited under 40 m by quicksand. The sandcarrying western winds remained dominant but became weaker, carrying only fine sand instead of common sand from the bed of the Danube. The eastern winds were carrying loess. This change was caused by an inland ice-cap beginning to develop. The development of an ice-cap could take place in a moist climate. This climate is proved by the fauna, too, because above 40 m it becomes suddenly richer and remains so. The change in fauna is not motivated by the change of sediment (the ancient substratum) but only by that of the climate. In a depth from 38 to 39 m, the quicksand with some loess is mixed also with a little humus, the remainder of a vegetation that had increased as a result of a more rainy climate. This change is also indicated by the fauna since in the sample from 38.5 to 39 m the number of „*Mollusca* exemplars altogether" is 615 and only 259 further below. The increase has affected the hygrophilic species (*Succinea oblonga,* hygrophilic ubiquitous species) while the thermophilic fauna changed hardly, so it was rather humidity than warmth which increased. The much poorer fauna of the next sample (from 38 to 38.5 m) corresponds to a more arid and colder milieu. This change may have been caused by the cold-storage effect of the ice-cap thickened as a result of the larger quantity of precipitation. The humus here may already be a consequence of the decay of former rich vegetation. From 37.5 to 38 m the material is loess with a little humus. With the predominance of loess-carrying eastern winds, a more arid and sunnier climate began. This change is indicated by the comparatively large amount of the thermophilic *Helicella hungarica* (15). The increase of the grove-dweller *Arianta arbostorum* (29) is also considerable. Otherwise, the fauna may be considered as an average type, as compared with subperiod III/12. From 36.5 to 37.5 m the material is fine sand with a little humus and loess. The sediment is similar to that between 38 and 39 m but the poor fauna corresponds to a much more arid and colder environment (subperiod (III/ /11.). That is easy to understand since the ice-cap was already considerably thick. From 35.2 to 36. 5 m the sediment is quicksand with a little loess. The western winds were more efficient, for they carried quicksand, but the eastern winds had also some effect since the loess formation went on. The considerably richer fauna without any thermophilic species indicates the cool humid climate, corresponding to the change (subperiod III/10).

After all, the loess containing sediments discussed here occupy an intermediate position between the loess adjacent from above and the loess-free sediment adjacent from below. They may be considered, therefore, only an a sediment of the oceanic period, introducing $Riss_1$ glacial.

From 40 m to 44.2 m (subperiod III/13) the sediment is quicksand. Here the quicksand means the predominance of western winds, the lack of loess the absence of eastern winds, and the lack of humus the absence of vegetation needed for humus formation. This deficiency of vegetation may be attributed to the cold weather. The cold, humid environment with an open vegetation, reconstructed from the fauna, entirely corresponds to these conclusions. The quicksand is still present in a 40 cm sample as far as 44.6 m. The fauna of that sample occupies an intermediate position between the middle dry (III) and the

lover humid periods (IV) but, on account of its richer aquatic fauna I have classed it rather amoung the latter. Further downwards, as far as 71 m, there follows a variable series of sediments without containing, however, any loess layer. This series of sediments may only be considered, on account of its location and extent, as a deposit of the Mindel-Riss (large interglacial). The quicksand of subperiod III/13 is therefore already the uppermost part of the Mindel-Riss interglacial.

Astronomical chronology

The previous publication colsed with the continental part of $Riss_1$ glacial. Moving back further towards older times, there follows on the climate curve of MILANKOVICH—BACSÁK the oceanic part of $Riss_1$ glacial, the first 5000 years of the $Riss_1$ glacial lastening for 11 000 years. It was a cold oceanic type of climate, when the inland ice-cap gradually developed. This period can be identified, on the basis of the data mentioned about their sediments and faunas, as the part of the profile ranging from 36.2 to 40 m. Further on, the climate curve is recording the Mindel-Riss interglacial, and at the end it shows a subarctic range of 5700 years. The formation time of the quicksand of subperiod III/13 can be identified with this part of the climate curve. The cold continental climate type offers reasonable explanation for the comparatively poor fauna of the subperiod and for the conditions reconstructed from it.

(To be continued)

Acta Biologica Szeged 17 (1—4), pp. 167—169 (1971)

PYCNOMESITIUS NEW GENUS FROM BETHYLIDAE (HYMENOPTERA)

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(Received June 25, 1971)

Among the large material of the British Museum Natural History originating from South Africa were some specimens which proved to be a new genera and species of subfamily Mesitinae (Bethylidae). The specimens similar to genus *Sulcomesitius* MÓCZÁR but different especially by the exteremely densely punctured abdominal tergite 2, the very fine longitudinal deepening on the mesonotum and by the shorter lateral spines of the propodeum.

Pycnomesitius gen. n.

Head, pronotum densely and coarsely punctured. Clypeus normal, longitudinal keel not delated medially. Eyes, ocelli normal developed. Mesonotum, scutellum sparsely punctured and shagreened only weakly shining. Posterior part of mesonotum with a small and fine deepening (♀ ♂) at least with an incomplete row of deep punctures. Scutellum convex without an incomplete row of deep punctures. Scutellum convex without an impression basally. Lateral spine of propodeum (♀ ♂) rather short, at most half as long as propodeum medially (♀) or shorter (♂). Wings fully developed or shortened sometimes (♀). Antennal joints 2—3 (♂) with quite different length, joint 3 nearly twice longer than 2 and with nearly parallel sides and with short dense hairs (♂) flagellar joints not thickened medially (♀). Almost the whole surface of abdominal tergite 2 deeply and extremely densely punctured, spaces between punctures at the densest part narrower than punctures. Body usually with pubescence and with hairs.

Type-species: *Pycnomesitius densepunctatus* MÓCZÁR ♀ ♂

Pycnomesitius densepunctatus sp. n.

♀. — Length 4.2 mm. Black, lower face, antennae brownish, head behind eyes and occiput, pronotum, mesonotum and propodeum partly legs yellowish red, abdominal segments partly dark reddish translucent, segments 5—6 yellowish-brown. Wings fully developed, fore wings rather dark infuscated with hyaline band without cells, veins brown. Head, thorax sparsely, abdomen more densely covered with light hairs.

Head slightly longer than broad (38 : 35), rounded like a half circle behind eyes viewed from above, without seeing the occipital carina; lateral sides, before eyes remakably convergent toward mandibles when viewed from above vertex: lateral sides distinctly convergent, posterior angles rounded and occipital margin nearly straight; POL : OOL = 6 : 8, outer margins of ocelli with only small and narrow grooves; frontal sulcus shallow, head very densely and rather deeply punctured, spaces between punctures shagreened and smaller than punctures; eyes rather convex, separated from mandibles by two-thirds distance of its length (10 : 15); temple broad only slightly broader than malar spaces (8 : 10); mandibles with 3 teeth; anterior margin of clypeus protruding semicircularly, lateral sides nearly parallel, surface raised steeply in longitudinal, sharp and high keel medially; antennae stumpy, scape, and only joints 2—3 longer than broad, the others quadrate, length (and breadth) proportions of antennal joints 1—13 = = 16/5 : 6/3.5 : 6/4 : 4/4 : 3.5/4 : 3.5/5 : 3.5/5 : 3.5/5 : 3.5/5 : 3/4 : 3/4 : 3/4 : : 6/4. Pronotum slightly more than two-thirds longer broad (18 : 25), lateral sides concave, anterior angles rather sharp, posterior margin nearly straigth, surface coarsely rugose, distinctly shagreened, matt, longitudinal furrow distinct, rather broad. Mesonotum distinctly shagreened, matt, with only some punctures, notauli and parapsidal furrow distinct, only a shallow and very short deepening in the middle. Mesonotum well separated from scutellum by a transverse groove and by pair of pits at its base laterally. Scutellum only shagreened basally, other parts with deep and large punctures. Propodeum short, half diameter of propodeal disc distinctly broader than long (17 : 14, on paratype 16 : 14), lateral spines stumpy, distinctly shorter than half length of propodeum (6 : 14, on paratype 5 : 14), carinae and areas of propodeum distinct (on paratype the sculpture finer), discal carina strongly bent and nearly parallel on its last quarter distally, sublateral area finely transversaly wrinkled-striated. Abdominal tergite 1 smooth, polished and very shining, 2 shagreened basally, then smooth shining and with slightly scattered puncteres on a small band, hence punctures becoming gradually deeper and extremly dense especially towards lateral-distal corners, a narrow band before posterior margin smooth, without punctures. Spaces between punctures only medially smooth and shining, towards lateral part shagreened and only hardly shining, segment 3 also very densely punctured and shagreened, 4—6 less distinctly punctured and only weakly shining; sternite 2 in the middle with scattered, towards laterally with gradually more dense and very deep punctures.

♂. — Length 3.8—4 mm. Very similar to female, only differing from it in characters as follows: head, ventral side of thorax, propodeum entirely black, only tip of mandibles yellowish brown. All antennal joints distinctly longer than broad, only segment 2 narrowed distinctly on its base, joints 3—13 with nearly parallel sides, at least twice as long as broad and densely covered with short and proclinate light hairs, hairs always shorter than half width of joints. Punctures of head larger than on female. Pronotum distictly broader than long (23 : 17), deeply punctured but not coarsely rugose. Lateral spines of propodeum shorter than on female, more stumpy, hardly protruding. Abdominal tergite 2 with the same sculpture, only the smooth and scattered punctured band slightly broader.

Specimens examined: „E. Cape Prov. Katberg. 4000 ft. Oct. 1932", „S. Africa. R. E. Turner, Brit. Mus. 1932—521" 1 ♀ holotype (London). — „C.

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Acta Biologica Szeged 17 (1—4), pp. 171—184 (1971)

EFFECT OF ION MILIEU AND BARIUM IONS ON THE VENTRICULAR ELECTROCARDIOGRAM OF THE EDIBLE SNAIL (HELIX POMATIA L.)

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(Received December 31, 1970)

The ECG of the heart of edible snail was described already by EVANS in 1912. He established, too, that, the barium ions exerting their effect in a physiological solution cause cardiac arrest and stop electric activity. Since then the literature in this field has become richer by the toxicological investigations of AKVANITAKI and CARDOT (1933) and the publication of SMIRNOV and TURPAEV (1948). There are also numerous publications treating of the effect exerted by the barium ions on the electric activity of various nerve and muscle structures. It is practically impossible to sum up these works completely.

The depolarizing effect of barium ions on various muscles is emphasized by the publications of BÜLBRING and KURIYAMA (1963), SPERELAKIS and LEHMKUHL (1968), ZETT and KÜCHLER (1969).

Fatt and GINSBORG (1958), SPERELAKIS and LEHMKUHL (1966), GERASIMOV and AKOEV (1967), GOMAA (1969) quote the effect of barium ions on different nerve and muscle tissues as initiating spontaneous activity and emphasize their capacity for lengthening the duration of action potential.

On the lobster axon and in respect of the stimulating effect on the release of acetylcholine DOUGLAS, LYWOOD and STRAUB (1961), BLAUSTEIN and GOLDMAN (1968), HAFEMANN (1969) consider the barium ions as substitutes for calcium while on other objects others deny this readiness (ZETT and KÜCHLER 1969).

Fatt and GINSBORG (1958) mention barium and strontium to be very permeable on the muscle membrane. Finally, the comprehensive publication of DIAMOND and WRIGHT (1969) discusses the selectivity rules of alkali-earth metals observed on the biological mebranes.

In earlier publications the present author has also dealt with the effects exerted by the barium ion on the functioning of the isolated hearts of edible snails (ERDÉLYI, 1965, 1967, 1968). The most characteristic of its effect was a strong tonic contracture observed both on smooth muscles and on the myocardium.

Recently I have investigated barium ions in respect to their effect on the electric activity under various ionic conditions in systems containing cations of one, two and more types.

Materials and Methods

In present work, the effects of barium ions on the ventricular action potential of the isolated edible snail (*Helix pomatia* L.) were investigated, as compared with other one-, bi-, or trivalent cations in an ion milieu of more and more complicated composition.

Electrical recording. An extracellular lead took place from the aortic end of the isolated heart ventricle with unipolar direct method, by use of non-polarizable Ag/AgCl electrodes. The leading off electrode was in contact with the arorta while the indifferent one sank into the bath and was connected to the amplifier through the common earth-point. The isolated heart ventricle was fixed at the end of the leading electrode, tightened with a weight of 1 g, at the atrial end cut asunder, and kept it in RIPPLINGER's (1957) oxygenated physiological solution. The monophasic action potentials were observed by means of a DC- amplifier of a DISA Universal Indicator and recorded with COSSOR camera.

The heart ventricle was allowed to beat in oxygenated physiological solution for 20 minutes after preparation. Then the ventricle was raised with its upper third part above the surface of the bathing fluid, the oxygenation was temporarily interrupted and the spontaneous electrical activity were lead off. In JULLIEN-RIPPLINGER's physiological solution (22 °C, pH: 7,4) there could be observed only a minor change in the form of the action potential in summer and autuum, as recorded by this method, even after 24 hours. The system is less sensitive to changes in pH from 4 to 8, but change in temperature causes considerable variation in the appearance of the action potential. The physiological solution was exchanged for further investigations by repeated washing for isotonic NaCl or sodium acetate (116.4 mM) and the effect of some of the following solutions was tested at 22 °C.

Ionic composition of the solutions used;

(1) Calcium-free solution: 112.4 mM NaCl, 4 mM KCl.

(2) Potassium-free solution: 112.4 mM NaCl, 4 mM $CaCl_2$.

(3) Potassium-free solution in which barium ions replace calcium ions:

a) 114.4 mM NaCl, 2 mM $BaCl_2$,

b) 112.4 mM NaCl, 4 mM $BaCl_2$,

c) 108,4 mM NaCl, 8 mM $BaCl_2$.

(4) Sodium-free solution: 112.4 mM Sucrose, 4 mM $BaCl_2$.

(5) Solution containing three kinds of cations:

a) 105,4 mM NaCl, 5 mM KCl, 4 mM $BaCl_2$,

b) 105.4 mM NaCl, 5 mM $CaCl_2$, 4 mM $BaCl_2$.

(6) Solution containing four kinds of cations: 111.4 mM NaCl, 1.87 mM KCl, 1.08 mM $CaCl_2$, 2,39 mM $Na(HCO_3)$, 4 mM $BaCl_2$.

(7) Chloride-free solution: 112.4 mM Na— acetate, 4 mM bariumacetate.

(8) Solution containing 50 percent chloride and 50 percent acetate 58.2 mM Na— acetate, 54.2 mM NaCl, 4 mM $BaCl_2$.

Organic ions (Tris, Cholinchlorid, TEA) were not used at all because the spontaneous electrical activity is strongly inhibited by them.

Investigations carried out by use of Ba—140 included the examination of Ba—140 uptake in a system containing 20 μC isotope, NaCl and as a carrier, 4 or 8 mM inactive $BaCl_2$ (at 22 °C, pH = 4,5, total volume: 100 ml).

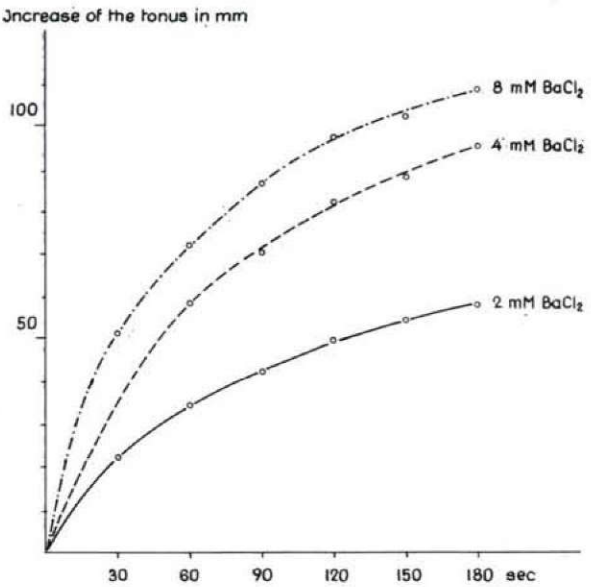
The was-out curve was plotted by elution in a physiological solution (22 °C, pH = 7,4) after 4 min. uptake period, on the basis of activity measurements of subsequent samples of 1 ml. The hearts examined were put into the eluent after rinsing for three times half minutes. The total volume of the eluent was 100 ml in this case too.

The hearts suspended on a small stand and loaded with a weight were treated a way identical with the control (physiological) experiments. At the investigation of the uptake each of the analysed samples contained four hearts in two parallel systems. In wash-out experiments four hearts were allowed to function in 100 ml physiological solution. The uptake and elution of the isotope were followed on the basis of the gamma radiation of Ba—140.

Results

The action potential obtained from the aortic end of the isolated heart ventricle in unipolar, ectracellular lead is monophasic and can readily be identified with the known biopotential types of the hearts of other molluscs and inverteb-

rates (NOMURA 1965, EBARA 1969, MCCANN and SANGER 1969). The observed cardiogram shows the characteristics of the atrial or pacemaker potentials of the vertebrate heart. As to the time course this electrical activity is readily comparable with the potentials of spontaneusly beating frog heart fragments (DOUARIN, RENAUD, LIGNON and NANOT 1968). The prepotential (diastolic depolari-



Graph. 1. Hypertonic effect of 2, 4, and 8 mM $BaCl_2$, as expressed in the function of time.

zation), with a duration of 500—1000 msec as depending upon the frequency of heart beat (at 22°C), can readily be indentified on the action potentials of the spontaneously functioning heart ventricle loaded with a weight of 1 g. Maximum depolarization of the prepotential is 2 to 4 mV. The duration of the spike potential is 200—500 msec, the peak potential is 12—20 mV in amplitude. The slow repolarization period shows a uniform decay. Sometimes, however a little negative or positive afterpotential may be observed, as well (Fig. 1).

The replacement of the physiological solution by isotonic NaCl results in characteristic changes of the ventricular electric activity. In isotonic NaCl solution the total duration of the potential increases and the spike period merges into the flattening action potential (Fig. 2, I. A., B). This process manifests itself still better in a calcium-free solution, as a result of the depolarizing effect of the potassium ions. In figures C of Fig. 2, the decreasing tendency of amplitudes can be well observed in the 2nd, 3rd, and 5th minutes. In a Na-free solution (isotonic cholinchlorid) the electric and mechanical activity is entirely arrested. If the heart is transferred from the isotonic NaCl into a potassium-free medium, the spike generation recovers, the spike amplitude and duration at-

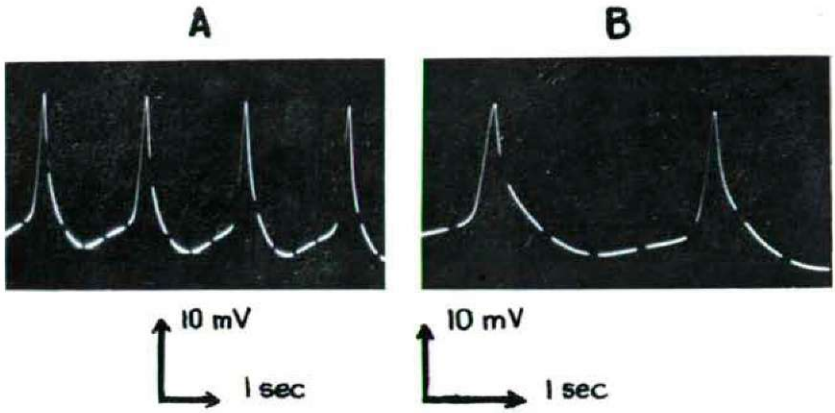


Fig. 1. Action potentials recorded from the aortic end of an isolated heart ventricle in JULLIEN-RIPPLINGER's physiological solution (22 °C, pH = 7,4). Recorded with A = 145 sec/m, B = 96 sec/m film speed.

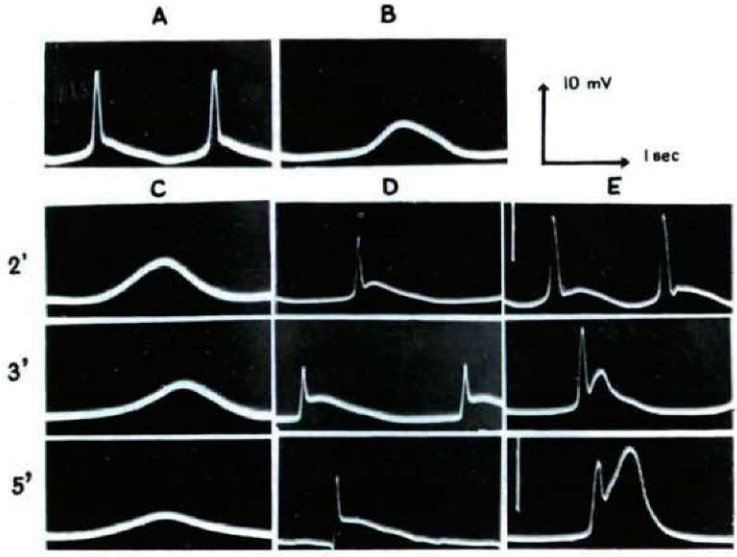
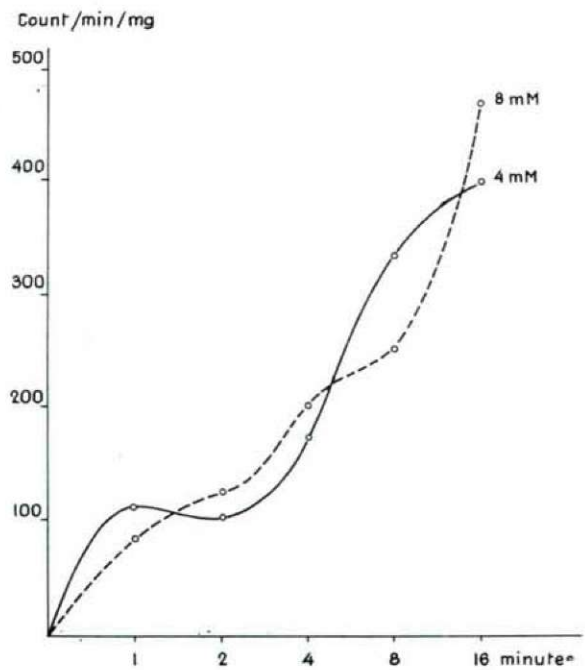


Fig. 2. Action potentials recorded in a medium containing one and two cations. A = control registered in a physiological solution, B = action potentials obtained in isotonic NaCl in the fifth minute, C = in a medium containing 112.4 mM NaCl and 4 mM KCl, in the second, third, and fifth minutes of the effects, D = in a medium containing 112.4 mM NaCl, 4 mM $CaCl_2$, in the second, third and fifth minutes of the effect, E = in a solution containing 112.4 mM NaCl, 4 mM $BaCl_2$, in the second, third and fifth minutes.

tains values observable in the physiological solution. At the same time, the prepotential period is modified, the slow period of repolarization becomes longer and a negativ afterpotential appears. Finally an ordinary spike generation restores with slower heart beat (Fig. 2., D).

Other experiments were directed to explore whether barium ions can substitute for calcium ions in respect of the spike generation. The action potentials seen in Figs. E of Table I were recorded in a medium where in a potassium-free solution barium ions substituted for calcium ions. It can be seen in the figures that the spike generation is unimpaired in the presence of barium ions, the pre potential is, however, less conspicuous.

The most striking change is, anyway, the increase in duration and the appearance of a strong negative afterpotential in the period of repolarization. The effect of barium ions was further analysed by investigating the doses of 2, 4 and 8 mM $BaCl_2$. In graph I, the tonic contracture-inducing effect of these three concentrations can be seen as the function of time, on the basis of several experiments in each case. It is obvious from the curves that the three barium ion doses, until reaching a saturation value, are able to bring the contractile system into a state of tonic contracture of different level, although the time course of contracture is similar in all the three cases.



Graph. 2. Uptake of Ba—140, expressed as fuction of time, from a medium containing 20 μC Ba—140, NaCl, and 4 mM or 8 mM $BaCl_2$. pH = 4.5, temperature 22 °C.

This may be explained on the basis of the concentration dependance of the uptake and supposed localization of barium ions. The experiments dealing with the uptake of Ba—140 actually show differences in respect to the intensity of ion-uptake, in systems containing 4 and 8 mM barium ions. The difference is however is not expressed enough in the concentration range exerting almost maximal physiological effect (graph 2).

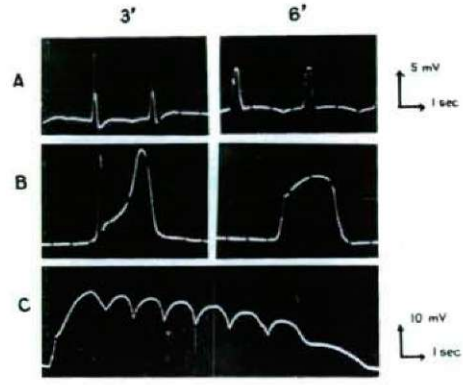


Fig. 3. Effect of 2, 4, and 8 mM $BaCl_2$ on the generation of the action potential. A = Modification of the action potential in a solution containing 114.4 mM NaCl, 2 mM $BaCl_2$, in the third and sixth minutes, B = in a medium containing 112.4 mM NaCl and 4 mM $BaCl_2$, in the third and sixth minutes, C = in a solution containing 108.4 mM NaCl and 8 mM $BaCl_2$, in the sixth minute of the effect.

It is probable that in this phase the course of uptake is disturbed by the exchange diffusion, releasing the isotope already received. So the effect of barium ions resulting in modifications of the action potential, proved to be more interesting. In Fig. 3 the effect of $BaCl_2$ (2 mM A., 4 mM B., 8 mM C) on the spontaneous action potential is demonstrated in the 3rd and 6th minutes after its application. As shown by the figures, the time course of the action potential is prolonged pari passu with the increasing barium concentration, first of all because of lengthening the repolarization phase. In addition, an afterpotential that is proportional to the dose, or rhythmical afterpotential-series are generated.

Other experiments were made to clarify whether the anions present modify the specific effect of barium ions. The presence or abesence of sodium ions has not any major influence on the form of the action potential because in the solution containing 112,4 mM sucrose and 4 mM $BaCl_2$ it is very similar to that observable in presence of sodium ions. In examining the role of anions, chloride ions were firstly substituted by acetate ions wich are considered to be unpermeable on muscle membranes (McCANN, 1964). Graph 3 demonstrates the effect of 4 mM $BaCl_2$ or barium acetate in media containing 100 percent chloride, 50 percent chloride-50 percent acetate, and 100 percent acetate, respectively it is apparent from the graph that the tonic contracture of the muscular system is the least in an acetate medium and the highest in a chloride medium, showing that a medium containing the highly permeable chloride anions may bring about more favourable conditions for the development of the hypertonic effect of the

barium ions than that containing acetate ions which have rather low permeability. In further experiment the effect on the action potential was investigated. The results of these experiments are shown in the physiological Fig. 4 A of Fig. 4, shows the action potentials observed in the physiological solution, Fig. B illustrates those observed in isotonic sodium acetate. Fig. C demonstrates the effect of 4 mM $BaCl_2$ or barium acetate in a medium containing 100 percent acetate, Fig. D in that containing 50 percent chloride-50 percent acetate, and Fig. E in that containing 100 percent chloride, in the 3rd and 6th minutes after application.

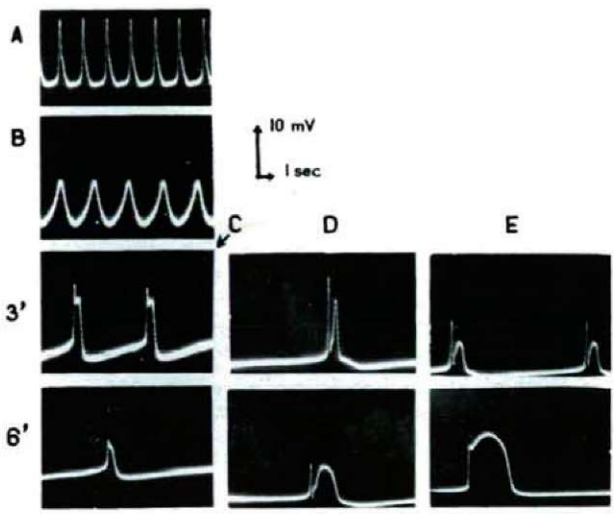
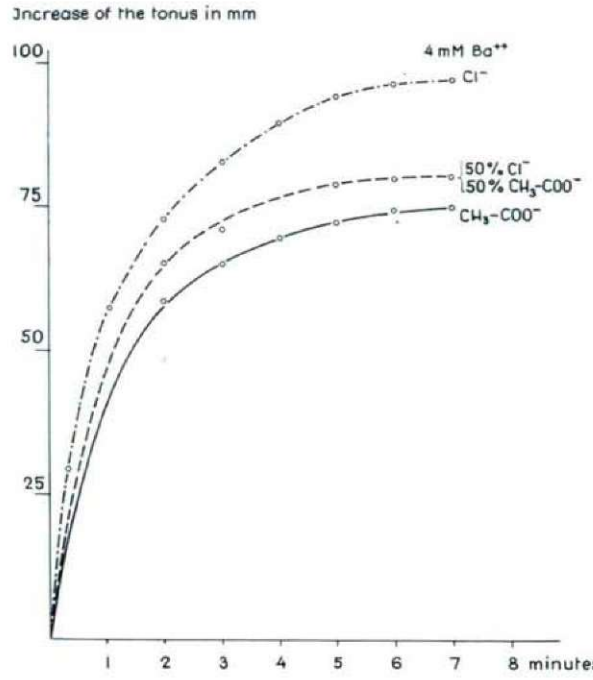


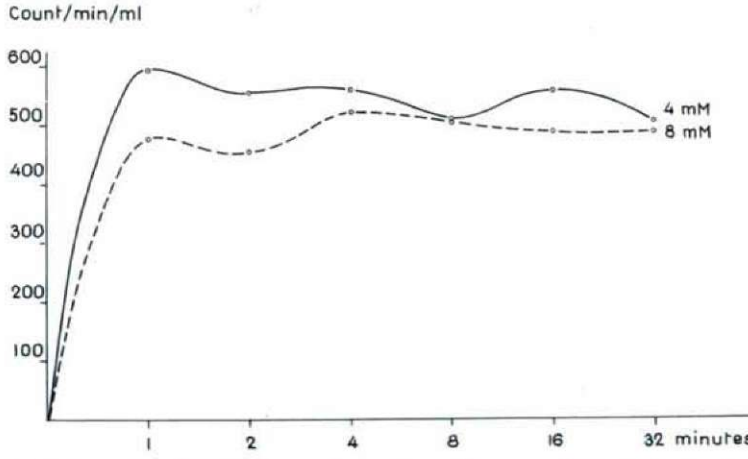
Fig. 4. Effect of barium ions on the generation of the action potential in a medium of chloride and acetate contents. A = control lead in a physiological solution, B = record made in isotonic Na-acetate, in the fifth minute, C = in a medium of 100 p. c. acetate contant (112.4 mM Na-acetate, 4 mM Ba-acetate), in the third and sixth minutes of the effect, D = in a solution containing 50 p. c. acetate — 50 p. c. chloride anions (58.2 mM Na-acetate, 54.2 mM NaCl, 4 mM $BaCl_2$) in the third and sixth minutes, E = in a medium containing 100 p. c. chloride anions (112.4 mM NaCl, 4 mM $BaCl_2$), in the third and sixth minutes.

In an acetate-type medium, in contrast to the medium with chloride content, the decrease of the potential duration is striking, and the negativ afterpotential is also depressed. The changes in the potential duration and in the tonic contracture proved to be entirely unequivocal.

The fact that calcium ions can be substituted for by barium ions in view of spike generation and furthermore that the contracture provoking effect of barium ions can be prevented by calcium ions administered in excess (ERDÉLYI, 1968), suggests that the two ions may be attacked to the same sites and, if both ions are present, there may be a competition for obtaining the same sites of binding. According to HAFEMANN's investigations, the sites of attackment are



Graph. 3. Hypertonic effect of barium ions in media containg 100 p. c. chloride, 100 p. c. acetate, 50 p. c. chloride and 50 p. c. acetate, respectively, plotted as a function of time.



Graph. 4. Wash-out curve plotted after a four min. taking up of Ba—140. Uptake took place from a system containing 20 μC Ba—140, NaCl, and 4 mM or 8 mM $BaCl_2$. Elution was performed in physiological solution: 22 °C, pH = 7.4.

likely also here the O_2-ligands (HAFEMANN, 1969). In this process — according to BLAUSTEIN and GOLDMAN (1968) — barium is more active than calcium. The strong barium-ion binding capacity of the system is shown by the wash-out curves, as well. Graph 4 shows the wash-out curve (in a normal physiological solution) of an isotope taken up for four minutes from a system containing NaCl, 4 or 8 mM $BaCl_2$, as well as 20 μC Ba—140.

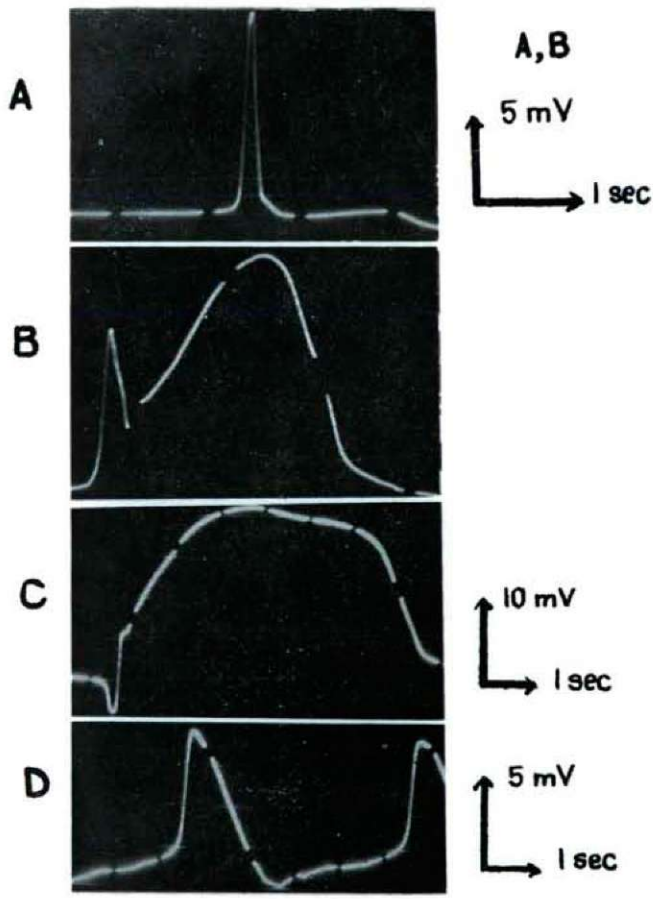


Fig. 5. Effect of barium ions on the action potential of an isolated heart ventricle. A = action potential lead in a physiological solution, B = effect of 4 mM $BaCl_2$ in the third minute, C = in the sixth minute, and D = action potentials lead in a physiological solution changed three times, after being eluted for six hours.

As it is shown by the curves, the delivery of barium ions linked loosely is already completed in the first minute while the firmly linked ions can hardly be released during the 32 minutes of the wash-out. At the end of washing, 53 percent of the Ba—140 taken up from the medium containing 4 mM $BaCl_2$, and

78 percent of that taken up from the medium containing 8 mM $BaCl_2$ were still bound.

A similar firm binding has to be supposed on the basis of the physiological events. Fig. 5 shows the results of an experiment demonstrating the action potentials. Record A of Fig. 5 was made about the heart kept in a physiological solution, record B in the third minute of the effect of 4 mM $BaCl_2$, record C in the sixth minute of that effect. The action potential seen in D was recorded after being washed out for six hours altogether in a physiological solution changed three times. In the course of washing, the gradual decrease in the after-potential can be observed, the duration becomes shorter, as well, without reaching the original value even at the end of the washing.

Later on, the effect of barium ions was investigated in a milieu where the number of kinds of cations was increased, bringing about in that way more and more complicated conditions on the outer side of the membrane. The results obtained are shown in Fig. 6 A demonstrates here, too, the action potentials recorded in the physiological solution, and Fig. B those in NaCl. The action potentials of Fig. C developed in a medium containing 105.4 mM NaCl, 5 mM KCl, and 4 mM $BaCl_2$, in the second, fourth, resp. sixth minutes of the effect.

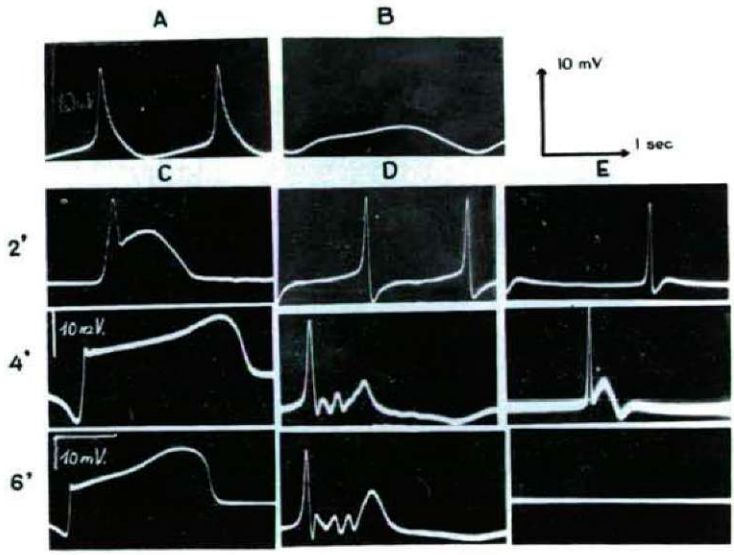


Fig. 6. Effect of barium ions on the generation the action potential in a medium containing three and four kinds of cations. A = control lead in a physiological solution, B = in isotonic NaCl in the sixth minute, C = in a solution containing 105.4 mM NaCl, 5 mM KCl, and 4mM $BaCl_2$, in the second, fourth, and sixth minutes, D = in a medium containing 105.4 mM NaCl, 5 mM $CaCl_2$ and 4 mM $BaCl_2$, in the second fourth, and sixth minutes, E = in a medium containing 111.4 mM NaCl, 1.87 mM KCl, 1.08 mM $CaCl_2$, 2.39 mM $Na(HCO_3)$, 4 mM $BaCl_2$, in the second, fourth, and sixth minutes of the effect.

It is obvious in the Figures that the presence of potassium ions exerts potentiating effect on the action of the barium ions increasing the potential duration, whereas the generation of after potential remains unchanged. In the prepotential and spike phases some changes can be observed, as well. The Fiugres D were obtained in a system containing 105.4 mM NaCl, 5 mM $CaCl_2$, and 4 mM $BaCl_2$. The prepotential is well developed, the spike generation is quite normal. In this experiment, the effect of barium ions is compensated by the calcium ions on the basis of the antagonism of the two ions.

The generation of afterpotentials continues here too. The joint presence of calcium and barium ions results in a membrane oscillation generating positive and negative afterpotentials. Figures E were made in a medium containing four kinds of cations (sodium, potassium, calcium, and barium). Here, probably because of the presence of potassium ions, the generation of positive and negative afterpotentials is depressed, the oscillation is driven back, the duration of prepotential, however, increases; then, from the fifth minute, a total electric silence ensues supposedly as a consequence of the complex interrelations of the four kinds of cations and of the disturbed equilibrium.

Discussion

The action potentials lead off extracellularly from the aortic end of the isolated heart ventricle of the edible snail are of the pacemaker type. From the changes experienced in different ion milieus, the conclusion may be drawn that the myocarium generates an action potential of mixed type, depending on Na——Ca ions. In this respect, we can observe some similarity to the results obtained in the giant neurons of *Aplysia,* as well as in the myocardium of *Mytilus* and the oyster (*Junge,* 1967; *Irisawa, Irisawa* and *Shigeto,* 1969). It seems that in the heart ventricle of the edible snail it is again the spike generation, that is particularly calcium-dependent.

According to our experiments, in this process calcium can be substituted by barium ions too. BÜLBRING and TOMITA (1968) have similarly observed the recovery of action potential in the smooth muscle taenia coli of a guinea-pig in a calcium-free solution in presence of barium ions. Some authors emphasize, however, that in other muscles the barium ions are not able to replace effectively the membrane-stabilizing capacity of calcium ions (ZETT and KÜCHLER, 1969).

The capacity of barium ions for increasing the duration of potentials and generating a negative afterpontential manifests itself in the heart ventricle of the edible snail, too, similarly to the results obtained by FATT and GINSBORG (1958) in lobster muscles, by GREENGARD and STRAUB (1959) in the B, C fibres of the rabbit, by BÜLBRING and TOMITA (1968) in the taenia coli smooth muscle of the guinea-pig. GREENGARD and STRAUB (1959) bring the retarded repolarization effect into connection with the repression of the inactivation of the sodium-carrier system. However, the matter is probably more complicated. This conclusion may be drawn from the publication of SPERELAKIS and LEHMKUHL (1968), as well, who observed an increase of the membrane resistance in a chicken heart culture as a result of barium ions, supposedly because of a decrease in the conductivity of potassium, followed also by a partial depolarization.

It is ascertained by isotopic experiments carried out with Ba—140 that the heart ventricle takes up barium ions. The influx of barium ions may take place along the ascending branch of the action potential. In accordance with the findings of FATT and GINSBORG (1958) in a lobster muscle, the snail heart ventricle can also be said to be highly permeable for barium ions. A considerable part of the ions taken up are bound very firmly and evoke the tonic contracture of the contractile system with an efficiency known in the smooth muscles. Barium is described also by LÁBOS (1967) in the glochidium closing muscle as an ion causing tonic contracture. This effect of barium ions is but hardly affected by the presence of sodium ions. The exchange of chloride however, for acetate ions, that are permeable only in a negligible degree, induces a considerable change both in the development of tonic contracture and in the retardation of the repolarization phase of action potential. The effect inducing tonic contracture may be due to an increase in potential duration by some unknown mechanism.

This is explanable by means of the connection between stimulus and contaction in the way that the barium ions entering the muscle extrude calcium ions thus making the latter ones cause a contracture. According to HAFEMANN's investigations (1969), namely, the excitability of lobster axon is also brought about by the calcium and barium ions throguh a binding site considered as a joint O_2-ligand. At the same time, the barium ions are not able to substitute directly for the specific part of calcium in the contraction. This is demonstrated also by the investigations of GAINER (1968) on a lobster muscle and those of ZETT and KÜCHLER (1969) on a frog muscle.

The increase in the number of kinds of cations in the medium induces more and more complicated conditions on the outer side of the membrane, that also influences the efficiency of barium ions. In the medium containing three cations (sodium, potassium, and barium) potassium ions have potentiating effect upon the action of barium ions increasing the duration of repolarization, correspondence to the tendency of both ions for systolization. The calcium ions, on the other hand, in accordance to the antagonism of the two ions, prevent the effect of barium ions on the duration of potentials. The generation of afterpotential, however remains and, owing to the diastolizing effect of the calcium ions, in the presence of barium ions, the membrane shows oscillations with a rhythmic potential generation.

After all, it seems that the barium ions exert their effect frist of all through the calcium-sensitive functional groups, ether in the way that they can substitute for the latter ions in some calcium-dependent process or by occupying the specifically calcium-sensitive sites, inducing changes in this way in the linked processes of the system. This seems to be supported also by the data of ZETT and KÜCHLER (1969) who found changes in frog's sartorius kept in a medium containing barium, first of all in the calcium content, while the sodium and potassium contents proved to be unchanged.

Summary

The effect of barium ions on the ventricular electrocardiogram of the edible snail (*Helix pomatia* L.) was investigated in different ion milieus and the following results were obtained:

1. The extracellularly recorded ventricular action potentials are of pacemaker type. The action potential is sodium- and calcium-dependent.

2. The spike generation is calcium-dependent but in that process barium ions can efficiently be substituted for the calcium ions.

3. The effect of barium ions exerted on the action potential is similar in a solution of sodium content and in that free of sodium (sucrose). The retardation of repolarization and the appearance of a negative afterpotential or afterpotential-series is characteristic.

4. The exchange of the chloride content of the investigated solution for impermeable acetate moderates the effect of barium ions causing tonic contracture and a retardation of repolarization.

5. In a system containing more kinds of cations the potassium ions potentiate the readiness of barium ions to increase the duration of potentials, while with calcium ions the action potential can be replaced to the physiological level, followed by a afterpotential-series with membrane oscillation.

6. Linked to similar sites, the barium ions exert their physiological and pharmacological effect primarily in the course of the calcium processes.

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Acta Biologica Szeged 17 (1—4), pp. 185—193 (1971)

PROBLEM OF ESTIMATING THE COINCIDENCE OF THE MONTH OF MENARCHE AND THE MONTH OF BIRTH

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(Received June 20, 1970)

In the course of investigating the bodily acceleratedness of Hungarian children, the physiological maturation has naturally aroused the interest of investigators. As a result of the latter researches, we have today perfectly reliable data, appraised with a modern method, on the basis of a very considerable number of collections from various parts of the country concerning the menarche-age of girls.

In analysing the questionnaires the investigators could simulteneously ascertain also in case of the Hungarian girls the phenomenon observed at first at the examination of Finnish girls (SIMELL, 1951). Namely the fact that the month of birth and the month of menarche do coincide in a higher percentage than expected. VALŠIK found the same with school-girls in BRNO (VALŠIK, 1953). Particularly after the findings of VALŠIK observation of that fact came into the foreground in Hungary. In our investigations performed in Southern Hungary we, too, adverted to the observation of that, furnishing further informations on its occurrence (FARKAS, 1962; 1963; 1964). The results of our data collected in Szeged recently — in 1966/67 — concerning the coincidence of the month of birth and month of menarche unpublished until now, are summarized in Table 1. Similar data of the girls at Kecskemét will also be published soon (FARKAS, 1970. Recently, having asked a very considerable number of young girls in Western Hungary, also other Hungarian authors have treated of the problem in details (EIBEN—BODZSÁR, 1970).

The observations concerning the coincidence of the month of menarche and month of birth are, therefore, the results of a discovery going back some twenty years. In Table 2 we are endeavouring to summarize until now the data that give evidence of the occurrence of this phenomenon. It appears from Table 2 that — considering the 12-month year as 100 per cent — we find in every sample, except the girls in Kecskemét, a higher percentage of coincidence than that corresponding to the monthly 8,33 per cent frequency expected. The question is staged, to which degree this percentual connection can be verified by statistical methods in case of Hungarian girls. Herewith I should like to report on our experiment concerning the investigation of this problem.

In this place I wish to express my thanks to research worker Péter Hunya, for his kind instructions concerning the statistical evaluation.

Materials and Methods

For performing our statistical investigations, our first task was to bring about a greater number of samples that may be considered with high probability to be unitary from several points of view. Concerning this programme we could rely on our earlier publications in which we elaborated the menarche-data of the young girls living in Southern Hungary and belonging to the Hungarian ethnic group. At this statistical test we have not been disturbed by the fact that we took into consideration the menarche-data of young girls from communities lying in different heights above sea level — Szeged, Pécs — however, the time of physiological maturation may be influenced by the height above sea level (VALŠIK—BERNÁTOVÁ, 1964). Our aim was to investigate the coincidence of the month of birth and month of menarche and not the menarche-median. On the basis of these considerations we have contracted our data collected in Szeged in 1958/59 and 1961, as well as in the neighbourhood of Szeged in 1961 (FARKAS, 1962), in Orosháza in 1963 (FARKAS, 1963), in Pécs in 1962 (FARKAS, 1964), in Kecskemét in 1964 (FARKAS, 1970), furthermore, in Szeged in 1966/67 (Table 1, Table 3, Fig. 1). In the following, I shall deal with these tables as data of the young girls from Southern Hungary.

In analysing the values available to me, I followed the method applied earlier by other authors, too (VALŠIK—ŠTUKOVSKÝ, 1963; EIBEN—BODZSÁR, 1970), i. e. I remodelled Table 3 according to DE RUDDER's n-method. The figures regrouped in this way (Table 4) are offering an easier survey about the combination of the month of birth and month of menarche in the contracted pattern investigated by me. Column n of the table is containing the cases in which the months of birth and menarche coincide with each other.

For facilitating a real comparison of similar investigations performed in differenc populations, I normalized Table 3, as well, (Table 6), regrouping it again according to DE RUDDER's n-method (Table 7).

On the basis of the third contingency table, for investigating the connection supposed between the two phenomena — the month of birth and month of menarche — we have reckoned the value of x^2, as well, by means of the following formula:

$$x^2 = n\left(\sum_{i=1}^{r}\sum_{j=1}^{s}\frac{v^{ij^2}}{v_i v_j} - 1\right)$$

In this formula, n = the number of available cases,

v_{ij} = value of the corresponding heading of the contingency table,
v_i = sum of the corresponding column (month of menarche) of the table,
v_j = sum of the corresponding line (month of birth) of the table (PRÉKOPA, 1962).

We have reckoned the index of interdependence of the two systems of events by the formula: $\frac{x^2}{n(q-1)}$. The contingency coefficient was established on the basis of the formula:

$$r = \sqrt{\frac{x^2}{q-1}},$$

where q = min (r, s).

About the monthly distribution of the month of birth and month of menarche I am getting information from Fig. 2. On the basis of the contingency table remodelled according to the n-method (Table 4), a joint description of three-three adjacent columns (Fig. 3) is given.

Table 1. Contingency table of the month of birth and month of menarche. — Girls in Szeged 1966/67

Month of birth	Month of menarche												Total
	I.	II.	III.	IV.	V.	VI.	VII.	VIII.	IX.	X.	XI.	XII.	
I	4	1	1	—	3	2	—	8	2	4	2	2	29
II	2	2	2	1	—	1	1	2	1	1	—	2	15
III	5	1	—	2	1	—	—	5	2	1	1	5	23
IV	4	1	—	1	—	3	1	5	2	2	—	2	21
V	2	2	2	—	2	1	1	1	—	1	1	—	13
VI	1	—	1	—	—	1	—	5	1	4	2	5	20
VII	2	3	2	—	1	—	2	3	1	—	1	2	17
VIII	—	1	—	—	—	—	2	7	1	5	1	2	19
IX	6	2	1	—	4	2	6	2	1	2	2	2	30
X	2	—	—	1	—	1	2	3	3	2	2	3	19
XI	3	—	—	—	1	1	1	3	1	—	3	2	15
XII	3	2	—	1	1	4	1	4	1	1	2	5	25
Total	34	15	9	6	13	16	17	48	16	23	17	32	246

Table 2. Coincidence of the month of birth and month of menarche at various patterns

Place of investigation	Author	Total cases	Coincidence	
			n	per cent
Finland	SIMELL, 1951	5741		11,9
Brno	VALŠIK, 1953	1473	217	14,7
Bratislava	VALŠIK, 1960	156	19	12,2
Szeged	FARKAS, 1962	771	104	13,49
Szeged	FARKAS, 1962	732	77	10,52
Environs of Szeged	FARKAS, 1962	416	36	8,65
Trnava	VALŠIK—ŠTUKOVSKÝ, 1963	894	123	13,7
Orosháza	FARKAS, 1963	222	33	14,86
Cadca	VALŠIK—BERNÁTOVÁ, 1964	538	54	10,04
Pécs	FARKAS, 1964	578	63	10,90
Kecskemét	FARKAS, 1970	282	23	8,15
Western Hungary	EIBEN—BODZSÁR, 1970	8255	946	11,46

Results

As shown by the percentual distribution at the bottom of Table 4, the months of birth and menarche are demonstrating a coincidence of 11,24 per cent, i. e. higher than the expected 8,33 per cent. That would mean, therefore, that the probability of coincidence of the month of birth with that of menarche is in practice much higher than the coincidence of the month of menarche with

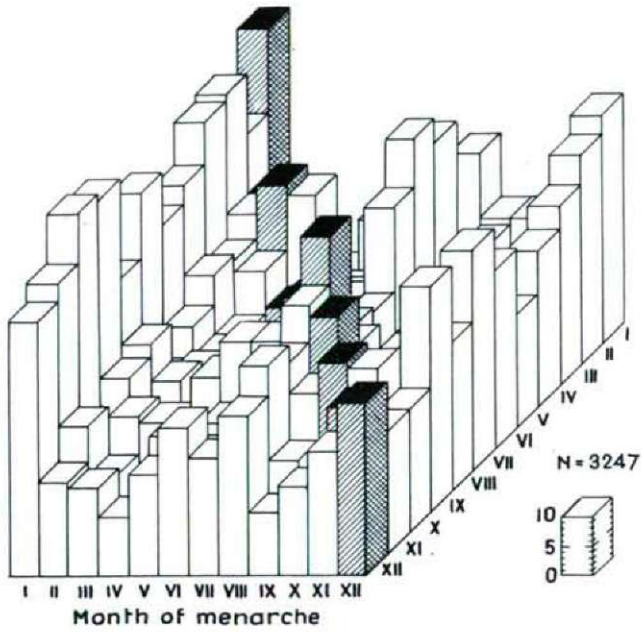

Fig. 1. Combinations of the month of menarche and month of birth at the girls in Southern Hungary

a month different from the month of birth, and vice versa. This phenomenon in our pattern is not influenced by that, some seasonal rhythmicity is also shown by the incidence of menarche (VALŠIK–ŠTUKOVSKÝ, 1964). In the winter months — as referred to earlier (FARKAS, 1962) — in case of the Hungarian girls, as well, the first menstruation occurs in a high percentage. In our present pattern menarche appears in 35,97 per cent in winter months. At the same time — i. e., in December, January and February — the percentage of births is 24,24 per cent altogether. That is to say, while the ratio of births is at about the expected value, the incidence of menarche in this season is considerably higher than the value expected. If the percentual value of the coincidence of the month of birth and of that of menarche depended unequivocally upon each other, so in that season also the percentual frequency of births ought to be higher. There may, however, be a great difference between the monthly percentual occurrence of the two phenomena what can be observed very well in the two coincidence

maxima of our pattern, in the months January and August. In these months the percentual frequency of births is approximately 7, resp. 4 per cent lower than the percentual incidence of menarche.

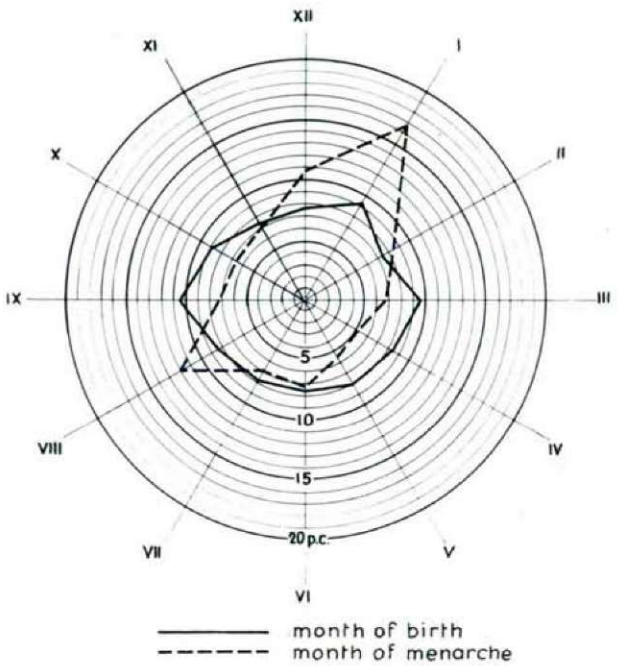

Fig. 2. Comparison of the percentile distribution of the months of birth and menarche in the pattern investigated

In Table 5, on the basis of one pattern from Czechoslovakia and two from Hungary, we can make a percentual comparison. It this table we find the empirical monthly percentual incidences as compared with the monthly mean incidences to be expected after the total case-number of the corresponding patterns having been divided by 12. It is striking at first sight that the empirical ratio of coincidence as compared with the average according to these values is 165,1 per cent in the pattern of Trnava (VALŠIK—ŠTUKOVSKÝ, 1963) while in the from Hungary it is about 30 per cent lower than that. The minimum value has been found at the girls in Southern Hungary.

Among the three patterns in case of the frequency above average, too, an essential difference is manifested (Tables 4 and 5). In the material of Southern Hungary, the average case number of incidence to be expected monthly is: $\bar{x} = 3247/12 = 270{,}6$. In the pattern from Trnava the frequency above the average is:

in case n—5	0,5	0,7 per cent
in case n—1	1,5	2,0 per cent
in case n+3	4,5	6,0 per cent
in case n	48,5	65,1 per cent

in the pattern from Western Hungary (EIBEN—BODZSÁR, in press):

in case n—1	31,1	4,5 per cent
in case n+1	42,1	6,1 per cent
in case n	258,1	37,5 per cent

in the pattern from Southern Hungary:

in case n—6	5,4	2,0 per cent
in case n—2	2,4	0,9 per cent
in case n+1	14,4	5,3 per cent
in case n+5	1,4	0,5 per cent
in case n	94,4	34,9 per cent

It would not be right of course to compare the absolute numbers with one another as the number of components is different in individual patterns. Nevertheless, it is remarkable that the percentage of frequency above average is similarly not equal in the three patterns (Trnava: 73,8 per cent, Western Hungary: 48,1 per cent, Southern Hungary: 43,6 per cent). The pattern from Trnava has the lowest number of components, nevertheless, the coincidence is the greatest in this pattern while it is considerably smaller in the other two patterns although, they have much more components. This renders probable the establishment that in observing this phenomenon the number of the experimental subjects has a particularly important role (VALŠIK—ŠTUKOVSKÝ, 1963). We may add, too, that in case of smaller patterns the percentage of coincidence is usually higher, although I am aware of other opinions, as well (EIBEN—BODZSÁR, 1970).

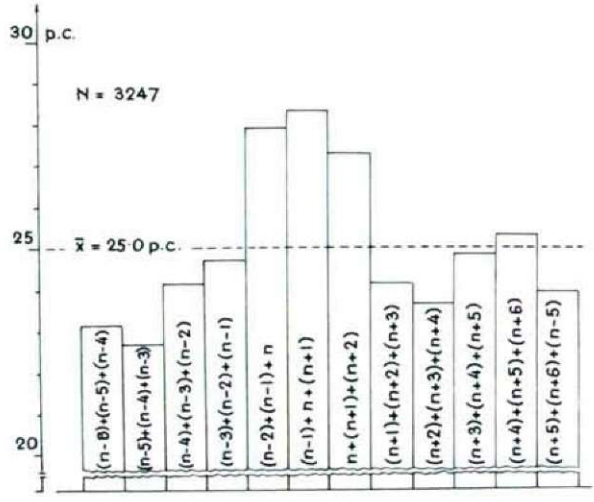

Fig. 3. Percentile comparison of three-three adjacent columns of the contingency Table elaborated according to De Rudder's *n*-method

Table 3. Contingency table of the month of birth and month of menarche on the basis of data from Southern Hungary

Month of birth	Month of menarche												Total	Per cent
	I.	II.	III.	IV.	V.	VI.	VII.	VIII.	IX.	X.	XI.	XII.		
I	*53*	23	17	12	21	20	22	32	21	21	20	38	300	9,24
II	39	*29*	16	11	10	18	19	19	20	12	10	35	238	7,33
III	49	29	*34*	32	16	13	17	41	17	14	17	30	309	9,52
IV	48	25	23	*17*	14	17	11	45	14	20	13	26	273	8,41
V	41	26	16	13	*21*	17	13	37	16	19	21	19	259	7,98
VI	38	21	16	8	7	*26*	18	23	16	20	19	30	242	7,45
VII	47	16	17	11	13	15	*26*	24	16	13	14	37	249	7,67
VIII	36	25	19	11	8	18	15	*43*	25	16	24	25	265	8,16
IX	53	23	11	12	23	29	29	35	*33*	24	23	38	333	10,25
X	54	17	20	19	9	19	21	29	24	*29*	28	21	290	8,93
XI	46	22	14	7	20	17	11	32	16	9	*25*	21	240	7,39
XII	43	16	15	10	17	25	20	27	11	15	21	*29*	249	7,67
Total	547	272	218	163	179	234	222	387	229	212	235	349	3247	—
Per cent	16,84	8,38	6,71	5,02	5,51	7,21	6,84	11,92	7,05	6,53	7,24	10,75	—	100,00

Table 4. Distribution of the combinations of the month of birth and month of menarche according to DE RUDDER's n-method

Months	Combinations of the month of birth and month of menarche													
	n−6	n−5	n−4	n−3	n−2	n−1	n	n+1	n+2	n+3	n+4	n+5	n+6	
I	22	32	21	21	20	38	*53*	23	17	12	21	20	22	300
II	19	20	12	10	35	39	*29*	16	11	10	18	19	19	238
III	17	14	17	30	49	29	*34*	32	16	13	17	41	17	309
IV	20	13	26	48	25	23	*17*	14	17	11	45	14	20	273
V	21	19	41	26	16	13	*21*	17	13	37	16	19	21	259
VI	30	38	21	16	8	7	*26*	18	23	16	20	19	30	242
VII	47	16	17	11	13	15	*26*	24	16	13	14	37	47	249
VIII	25	19	11	8	18	15	*43*	25	16	24	25	36	25	265
IX	11	12	23	29	29	35	*33*	24	23	38	53	23	11	333
X	19	9	19	21	29	24	*29*	28	21	54	17	20	19	290
XI	20	17	11	32	16	9	*25*	21	46	22	14	7	20	240
XII	25	20	27	21	15	21	*29*	43	16	15	10	17	25	274
Per cent	8,50	7,05	7,58	8,10	8,41	8,25	11,24	8,78	7,24	8,16	8,31	8,38	8,50	
ΣN	276	229	246	263	273	268	365	285	235	265	270	272	276	3247

Table 5. Percentual frequency of menarche as compared with the average in three patterns

	n−6	n−5	n−4	n−3	n−2	n−1	n	n+1	n+2	n+3	n+4	n+5	n+6
$\frac{n \cdot 100}{\bar{x}}$	Trnava												
	95,3	100,7	91,3	89,9	95,3	102,3	165,1	84,6	76,5	106,0	99,3	94,0	95,3
	Western Hungarian												
	90,6	89,0	95,1	99,9	94,8	104,5	137,5	106,1	92,2	98,0	94,6	97,8	90,6
	Southern Hungarian												
$x = \frac{\Sigma n}{12}$	102,0	84,6	90,9	97,2	100,9	99,0	134,9	105,3	86,8	97,9	99,8	100,5	102,0

Table 6. Normalized contingency table of the month of birth and month of menarche

Month of birth	Month of menarche												Total
	I.	II.	III.	IV.	V.	VI.	VII.	VIII.	IX.	X.	XI.	XII.	
I	*0,1767*	0,0767	0,0567	0,0400	0,0700	0,0666	0,0733	0,1067	0,0700	0,0700	0,0666	0,1267	1,0000
II	0,1639	*0,1219*	0,0672	0,0462	0,0420	0,0756	0,0978	0,0798	0,0841	0,0504	0,0420	0,1471	1,0000
III	0,1586	0,0939	*0,1100*	0,1035	0,0518	0,0421	0,0550	0,1327	0,0550	0,0453	0,0550	0,0971	1,0000
IV	0,1758	0,0916	0,0842	*0,0623*	0,0513	0,0623	0,0403	0,1648	0,0513	0,0733	0,0476	0,0952	1,0000
V	0,1583	0,1004	0,0618	0,0502	*0,0811*	0,0656	0,0502	0,1429	0,0618	0,0733	0,0811	0,0733	1,0000
VI	0,1570	0,0868	0,0661	0,0331	0,0289	*0,1074*	0,0744	0,0950	0,0661	0,0827	0,0785	0,1240	1,0000
VII	0,1887	0,0643	0,0683	0,0442	0,0522	0,0602	*0,1044*	0,0964	0,0643	0,0522	0,0562	0,1486	1,0000
VIII	0,1359	0,0943	0,0717	0,0415	0,0302	0,0679	0,0566	*0,1623*	0,0943	0,0604	0,0906	0,0943	1,0000
IX	0,1591	0'0691	0,0330	0,0360	0,0691	0,0871	0,0871	0,1051	*0,0991*	0,0721	0,0691	0,1141	1,0000
X	0,1862	0,0586	0,0690	0,0655	0,0310	0,0655	0,0724	0,1000	0,0828	*0,1000*	0,0966	0,0724	1,0000
XI	0,1917	0,0917	0,0583	0,0292	0,0833	0,0708	0,0458	0,1333	0,0667	0,0375	*0,1042*	0,0875	1,0000
XII	0,1727	0,0643	0,0602	0,0402	0,0683	0,1005	0,0803	0,1084	0,0442	0,0602	0,0843	*0,1165*	1,0000
Total	2,0246	1,0136	0,8065	0,5919	0,6592	0,8716	0,8196	1,4274	0,8397	0,7474	0,8718	1,2968	12,0000

Table 7. Normalized distribution of combinations of the month of birth and the month of menarche accordint to De Rudder's n-method

Months	Connection of the months of birth and menarche												
	n−6	n−5	n−4	n−3	n−2	n−1	n	n+1	n+2	n+3	n+4	n+5	n+6
I	0,0733	0,1067	0,0700	0,0700	0,0666	0,1267	0,1767	0,0767	0,0567	0,0400	0,0700	0,0666	0,0733
II	0,0798	0,0841	0,0504	0,0420	0,1471	0,1639	0,1219	0,0672	0,0462	0,0420	0,0756	0,0798	0,0798
III	0,0550	0,0453	0,0550	0,0971	0,1586	0,0939	0,1100	0,1035	0,0518	0,0421	0,0550	0,1327	0,0550
IV	0,0733	0,0476	0,0952	0,1758	0,0916	0,0842	0,0623	0,0513	0,0623	0,0403	0,1648	0,0513	0,0733
V	0,0811	0,0733	0,1583	0,1004	0,0618	0,0502	0,0811	0,0656	0,0502	0,1429	0,0618	0,0733	0,0811
VI	0,1240	0,1570	0,0868	0,0661	0,0331	0,0289	0,1074	0,0744	0,0950	0,0661	0,0827	0,0785	0,1240
VII	0,1887	0,0643	0,0683	0,0442	0,0522	0,0602	0,1044	0,0964	0,0643	0,0522	0,0562	0,1486	0,1887
VIII	0,0943	0,0717	0,0415	0,0302	0,0679	0,0566	0,1623	0,0943	0,0604	0,0906	0,0943	0,1359	0,0943
IX	0,0330	0,0360	0,0691	0,0871	0,0871	0,1051	0,0991	0,0721	0,0691	0,1141	0,1591	0,0691	0,0330
X	0,0655	0,0310	0,0655	0,0724	0,1000	0,0828	0,1000	0,0966	0,0724	0,1862	0,0586	0,0690	0,0655
XI	0,0833	0,0708	0,0458	0,1333	0,0667	0,0375	0,1042	0,0875	0,1917	0,0917	0,0583	0,0292	0,0833
XII	0,1005	0,0803	0,1084	0,0442	0,0602	0,0843	0,1165	0,1727	0,0643	0,0602	0,0402	0,0683	0,1005
Total	1,0518	0,8681	0,9143	0,9628	0,9929	0,9743	1,3459	1,0583	0,8844	0,9684	0,9766	1,0023	1,0518
Per cent	8,77	7,23	7,62	8,02	8,27	8,12	11,22	8,82	7,37	8,07	8,14	8,35	8,77

From the above enumeration it is apparent at once that a frequency greater than average can be found in the three patterns not in the same months.

Comparing the percentual values of Tables 4 and 7 with one another, we have found the greatest difference — 0,27 per cent — at column marked n—6. It also appears from the normalized contingency table that the percentual sum of column n considerably rises above the other values.

The value of the reckoned x^2 is 171, 539. The number of degrees of freedom is: $f = (r-1)\ (s-1) = 121$. The value of x^2, determined by extrapolation, lies on a 0,1 per cent level between degrees of freedom 100 and 121; therefore, the hypothesis of independence can not be rejected. The index of the interdependence of the two event-system is 0,004802. In order that an event exerts an influence on another, its value must be four orders of magnitude greater. We have to draw the consequence, therefore, that the month of menarche is not determined by the month of birth but, owing to the facts mentioned above, they cannot be considered as independent of each other, either.

The contingency coefficient is 0,0693. That refers to, as well, that statistically there cannot be demonstrated any verified connection between the two phenomena. This fact, perfectly agrees with an earlier observation of VALŠIK (1953) i. e. there is no mathematical correlation between the month of birth and that of menarche. We cannot expect, therefore, any result for interpreting this phenomenon from the calculation of correlation coefficients, either.

At the same time, we have experienced concerning the intensity of coincidence the fact referred to by VALŠIK, namely that the frequency of coincidence may be influenced to some degree by the size of the community investigated. In Table 2, we have found very similar coincidence percentages in two towns of approximately equal in size, Szeged and Pécs, while at the girls of some villages in the neighbourhood of Szeged the degree of coincidence is considerably lower. This fact is not at variance with that in case of a comparatively large town, Kecskemét, where the value of coincidence is similarly low. The inhabitants of that town belong even today to those engaged first of all in agricultural production.

Discussion

On the basis of our investigations we have established that the coincidence of the months of birth and menarche, even if showing a higher frequency than the average, cannot be verified statistically, after all, and therefore, we must look for other determinants. The statements of VALŠIK and ŠTUKOVSKÝ are greatly supported by our calculations.

In our opinion, with this phenomenon we must take into consideration, as well, that menarche is purely a biological phenomenon while the month of birth is greatly influenced by several social factora (customs, family planning separation owing to seasonal work, etc.). We mention for example that in the pattern of Trnava the most birth fall on the month of June, in the pattern of Southern Hungary, however, they fall in a very high degree on the month

of September and in the pattern of Western Hungary they fall on the month of September and March. We only wanted to illustrate with these data that the social factors cannot be disregarded when interpreting this problem.

For studying this phenomenon by any method, it would first of all be necessary to ascertain that the dates declared by the girls correspond to truth. It is, however, shown by the experiences gained so far that we may be impeded by several factors in reaching this purpose. The first task is, therefore, to eliminate this disturbing factor.

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Acta Biologica Szeged 17 (1—4), pp. 199—207 (1971)

SUPPOSITION OF GENETIC CONNECTIONS BETWEEN THE FINDS OF THE CEMETERY AT MÉLYKÚT–SÁNCDŰLŐ (SOUTHERN HUNGARY) ON THE BASIS OF BLOOD GROUPING ABO

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(Received May 31, 1971)

In the vicinity of the village Mélykút, in the Southern part of Hungary between Rivers Danube and Tisza, altogether 54 graves were excavated in 1959 and 1968 (KŐHEGYI, 1960; 1969), partly from the late Sarmatian Age (7 graves), partly from the early Avar Period. The finds are deposited in Department of Anthropology, Attila József University, Szeged and their morphological and metric analyses have been concluded in the recent past (MARCSIK, in press). We do not wish to treat here, therefore, the results of evaluation of these finds with the traditional anthropological methods.

The primery aim of this paper is to attempt a more detailed analysis concerning the structure of the cemetery on the basis of the map of this Avar cemetery of low grave-number, as well as of the blood typing carried out by IMRE LENGYEL.

A	B	O	AB	NSe	
22,91%	20,83%	22,91%	25,00%	8,33%	
p	q	r			x^2[1]
0,2302	0,2117	0,5579			12,77

$P > 0{,}001$ extreme significance

The results concerning the distribution of morphological sex, age, blood-groups and collagen-types are given in Table 1. We have taken into consideration also the morphological characteristics, anatomical variations, pathological deformities, as well as the result of the taxonomic determination, bringing them into connection with the archaeological furniture.

In the cemetery map of the excavation of 1968 (Fig. 1) it is obvious that the graves lie in the direction of NW—SE, in general along two lines that can easily be separated from each other. Consequently, we inferred that two large families were buried in this cemetery. It could also be ascertained on the basis of the decomposition quotient (LENGYEL, 1970) that within both families, advancing from NW to the direction SE, some chronological differences may be encountered, i. e., the direction of buryings points from NW to SE. On that basis, the graves can be divided in both large families into four groups each

Table 1. Distribution of the morphological sex, age, blood-group and type-collagen of the finds from Mélykút—Sáncdűlő in 1968.

Number of grave	Morphological		Bloodgroup	Type of collagen
	sex	age		
4.	female	Ad.	B	c
8.	female	Ad.	A	c
9.	male	Ad.	NSe	a
10.	male	Mat.	O	a
11.	—	Inf. I.	A	d
12.	male	Ad.	O	a
13.	female	Mat.	AB	d
14.	female	Ad.	AB	c
15.	—	Inf. II.	O	b
16.	female	Mat.	O	a
16—17.	—	Inf. I.	AB	b
17.	female	Ad.	B	a
18.	—	Inf. II.	B	c
19.	male	Ad.	O	c
21.	male	Ad.	A	a
22.	female	Ad.	AB	d
23.	male	Mat.	NSe	b
24.	female	Juv.	A	a
25.	male	Mat.	O	d
26.	male	Mat.	NSe	a
27.	female	Ad.	O	b
28.	female	Juv.	A	c
29.	female	Ad.	AB	a
30.	female	Ad.	AB	b
31.	female	Mat.	A	a
32.	female	Mat.	A	c
33.	male	Mat.	B	a
34.	female	Mat.	B	d
36.	female	Ad.	O	d
37.	male	Mat.	NSe	a
38.	—	Inf. II.	A	a
38a.	female	Ad.	A	c
39.	female	Mat.	AB	d
40.	female	Mat.	B	a
41.	female	Ad.	O	b
42.	male	Mat.	B	b
43.	female	Ad.	B	a
44.	male	Ad.	A	c
45.	male	Ad.	AB	d
46.	female	Mat.	O	c
47.	female	Juv.	AB	a
48.	—	Inf. II.	B	a
49.	male	Juv.	B	c
50.	male	Ad.	AB	d
51.	male	Ad.	O	a
52.	female	Mat.	A	b
53.	—	Inf. I.	AB	b
54.	female	Ad.	AB	a

Grave 4 is from Sarmatic-Age (excavation 1959)

a = α c = γ
b = β d = δ

where between the first and last buryings we can calculate an interval of 80 ± 20 years. The members of both families were therefore buried in that place in four periods, as rendered probable also by the fact that there can generally be observed greater distances between the graves separated chronologically within the families and in the cemetery map, as well.

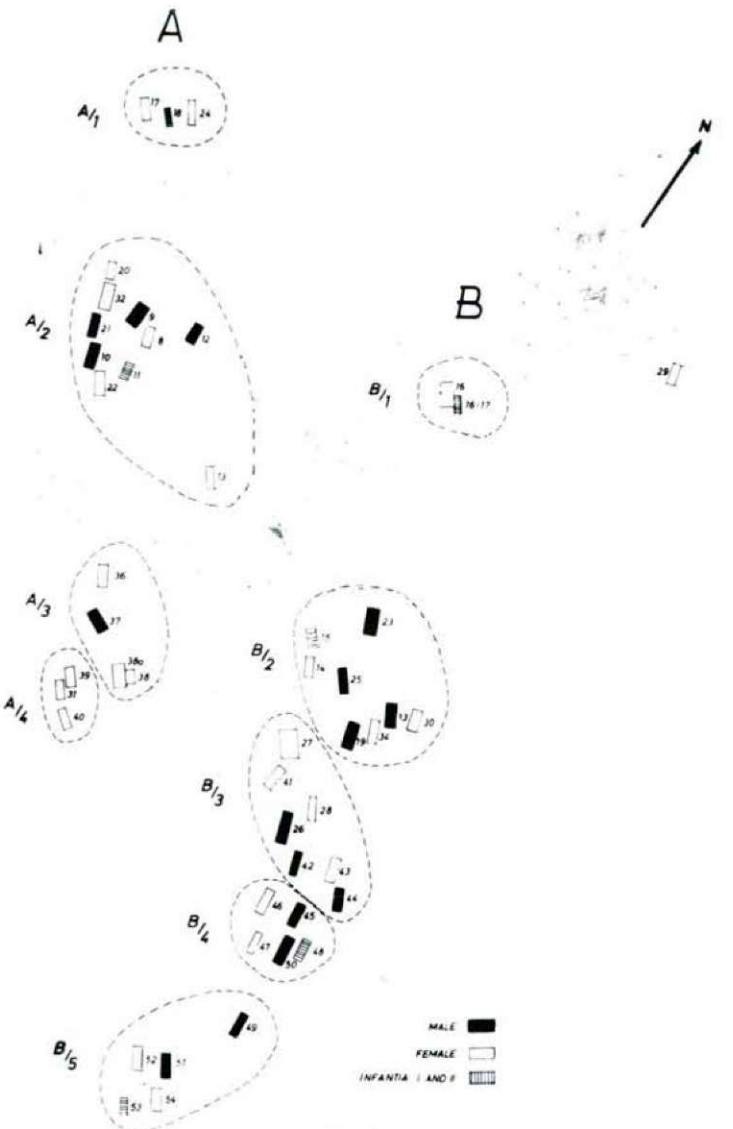

Fig. 1

If our suppositions are reliable, then advancing from NW to SE, there are genetic connections within the families on the basis of ABO blood grouping. As in the cemetery there were buryings in four different periods, it may be supposed that the graves representing the single families in the periods are only meaning some proportion of the number of family members.

It appears on the basis of the cemetery map that there is some phase displacement between the beginnings of the two family-buryings as the family located on the NW—SE side of the cemetery began the burying in this area earlier than the other family located east from there.

After these preliminary remarks, on the basis of blood typings (FARKAS, 1970), we supposed the following genetic connections.

A) In case of the family located on the NW—SE side:

1. Among the graves of first family (graves 17, 18 and 24), located to the most NW, supposing a father of blood group AB, there can be established two generations. Generations F_1 from which the child finds of graves 18 and 24 originated, is represented by the female find of grave 17 and the supposed father, as parents (Fig. 2). This supposition is confirmed also by that in case of all the three finds a somewhat protruding, knobby protuberantia mentalis can be found. At graves 17 and 18, planoccipitalia may be observed.

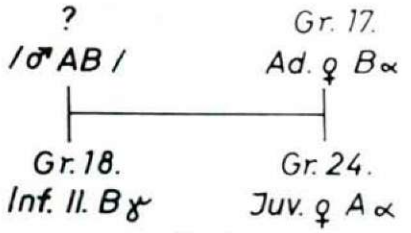

Fig. 2

2. Within the family, the second group that can be separated chronologically, is represented by ten graves (graves 8, 9, 10, 11, 12, 13, 20, 21, 22, 32). On the basis of these graves we concluded that the individuals buried in graves 13, 20, 21 and 22 were brothers and sisters, rendered probable partly by their chronological conformity and partly by their identical taxonomic characteristics.

For ascertaining the genetic connection of graves, we have to suppose a mother of blood group A and a father of blood group AB. Descendants of these may have been the finds of graves 13, 20, 21 and 22. The male of age maturus and of blood group A, buried in grave 21, forms the parent-couple with the female of blood group A with characterictics differing taxonomically from those of his (grave 32): their children belonged to generation F_3 and buried in graves 8, 9 and 12. From among the four brothers and sisters mentioned above, the adult female of blood group AB, buried in grave 22, together with the male of blood group O, buried in grave 10, are representing the second parent-couple whose child is the young person of blood group A buried in grave (Fig. 3).

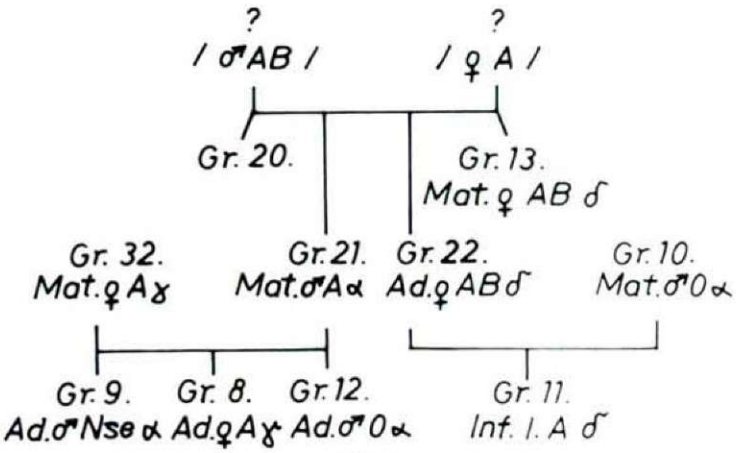

Fig. 3

The genetic connection of the find of graves 21 and 22 is supported by the knobby protuberantia mentalis, too, little protruding on the mandible, apart from the fact that both of them can be ranked into the gracile Mediterranean race. At the find of graves 10 and 11, between whom a parent-child connection is supposed, on the mandible a border can be found. The supposed mother, buried in grave 32, transmitted her collagenous type as a consequence of her spondylosis also to his (supposed) child buried in grave 8.

3. Two different groups chronologically differing from each other also belong to this group. Graves 31, 36, 37, 38, 38a, 39 and 40 may be classed among the older and therefore earlier buried group, the same as a supposed father of blood group B. The parent-couple is represented by the female find of blood group O from grave 36, and by the NSe male find from grave 37. The female of blood group A grave 38a may be originated from these. This forms together with the supposed father of blood group B, the second parent-couple whom the persons buried in graves 38, 39, 31 and 40 may have descended from.

The finds of graves 38a and 36 can be classified into the Pamirian race, with both of them curvoccipitalia being found. On the basis of the excavation record, also the uncovering of the find of the male supposed must have taken place but the material of that grave is not available for us. At the finds of graves 38a and 39, there is knobby protuberantia mentalis. The individuals buried in graves 31, 39 and 40 may be determined in all the three cases females of maturus age and, in addition, at the finds of graves 31 and 40 also the type-collagens agree. That consequently supposes genetic connection. These three females separate chronologically, as well, from the seven graves mentioned previously (Fig. 4).

This large family (group A) is comparatively poor in archeological furniture. In our opinion these were buried first in this area. That is supported also by that, within the group, there are also graves that may chronologically be dated to have been contemporary with the Sarmatians (17, 18, 22, 24 and 13).

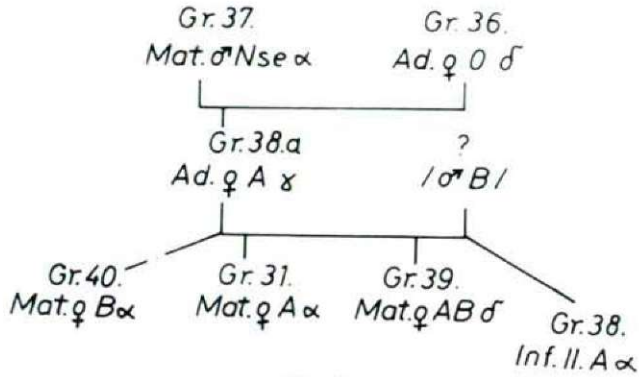

Fig. 4

B) The other large family is located east from the group marked with A. That can be also divided chronologically into four parts.

1. In the most NW part of the line we have found only a single grave (16) that may be determined to be of the Avar Period. Although beside this grave there was excavated also another find, the orientation of that differs from the graves coming from the Avar Period, and may be dated also on the ground of the decomposition quotient to be chronologically younger — a Sarmatian one. There is a similar situation at grave 29. On the basis of the female find of maturus age excavated from grave 16 it is very difficult to draw any conclusion. It may be anyway supposed that this may have been a member of a parent-couple. The grave chronologically agrees with the graves of A/2 group.

2. In approximately southern direction from the grave mentioned, in a rather great distance, we find a group consisting of eight graves, chronologically of about the same age as group A/3 (graves 14, 15, 19, 23, 25, 30, 33, 34). This group is first of all interesting because the definitely Mongolid find of grave 25 is of central situation and the other seven graves surround it. As in case of the latter ones we have not been able to discover any Mongoloid features, it seems to be probable that that Mongolid individual, by the way buried with gold furniture, may have held some leading role, and the persons buried around

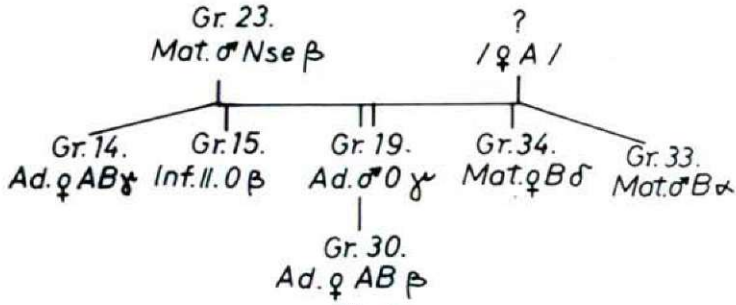

Fig. 5

him have been his subordinates. It is an add thing about this find that a „trepanation" round the foramen magnum can be found on the cranium.

On the basis of the above data, the following genetic connection may be supposed (Fig. 5).

The members of the parent-couple must have been the NSe father (probably of blood group) buried in grave 23 and an unknown mother (probably of blood group A). The descendants of these parents may have been the individuals buried around grave 25. This is also supported by the fact that the finds of graves 14, 23, 30, 33, 34 are very similar to one another as to their morphological features. From taxonomical point of view, the characteristics of the gracile Mediterranian and those of the Nordoid race are to be recognized on them.

Taking into consideration the archaeological records, it does not seem impossible, either, that the wife of the male individual in grave 25 was the adult female buried in grave 14 because only in these two graves of this grave-group were found any gold furniture.

3. The third group of this family is formed by seven graves that may be considered to have the same chronological age as group A/4 (graves 26, 27, 28, 41, 42, 43 and 44).

As on the basis of the morphological characteristics the finds of graves 26, 27 and 28 are very similar and, at the same time, at the finds of graves 26 and 42 sutural bones could be found, respectively, from a taxonomical point of view, one of them can be determined as Nordoid and the other as Atlanto-Mediterranean, we have supposed the following genetic connections (Fig. 6).

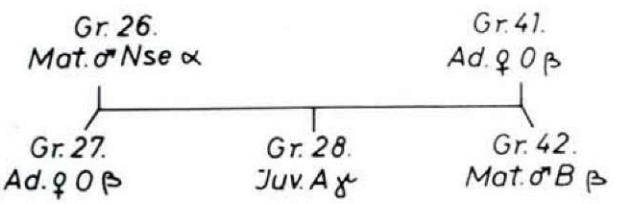

Fig. 6

The parent-couple are represented by the female find of grave 41 and the male find of grave 26. This individuals buried in graves 27, 28 and 42 may have descended from then. The other parent-couple are respresented by the individuals of the other graves (43 and 44). From them may have descended the members of the following group B/4.

4. Into this group five finds (graves 45, 46, 47, 48 and 50) were classified. On the basis of the above data, these individuals descended from the male, respectively female member of graves 43 and 44 (Fig. 7). This supposition is supported by that the finds of graves 44 and 50, as well, may be ranked among the Pamirian race and they seem to agree to a great extent in morphological features.

5. Group 5 of the second family is represented by five individuals (graves 49, 51, 52, 53, 54). This group chronologically agrees with the finds of group

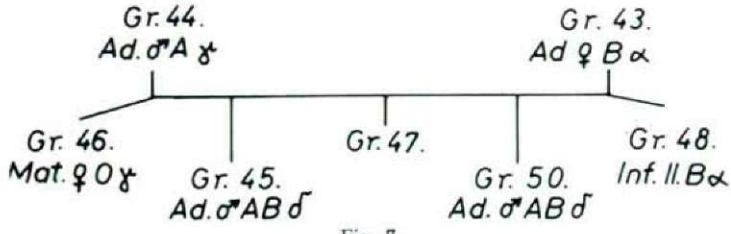

Fig. 7

B/3. It may be imagined, therefore, that this group meant perhaps the origin of a new large family. Anyway, on the basis of blood groups, there may be supposed a genetic connection between them, as well (Fig. 8).

In this case, the male find of grave 51 and the female find of grave 54 are forming the parent-couple whom the individuals of graves 49 and 52 descended from. The latter one, in case of a supposed father of blood group A or AB can be considered as a member of a newer parent-couple, having as descendant the subadult individual of grave 53.

It is characteristic of both large families that the descendants can be found either nort or south of the parents supposed, although group B/2 is an exception. It is striking, too, that in the cemetery the female members of the parent-

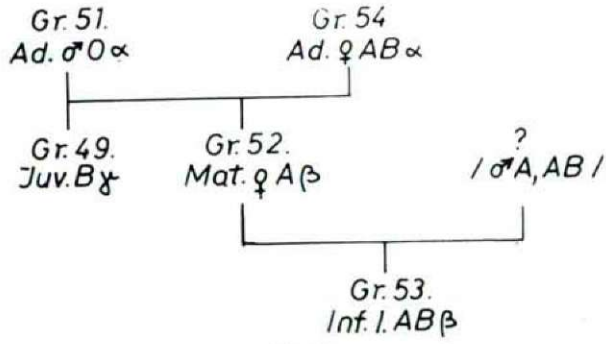

Fig. 8

couples assumed by us are generally buried on the NW side as compared to their probable husbands. And if the matter in question is the situation of two parent-couples then the graves are located along the NW—SE line in the way that the males lie in the middle and the females NW, respectively SE from there. This system of burying may be correct even if the parents not buried but supposed by us are included in this arrangement.

Summing up the discussed data, we have to emphasize that our expounded idea concerning the funeral rites is a working hypothesis founded on genetic connections supposed on the basis of the blood group system ABO that can be determinded exactly. At any rate, this cemetery differs from other cemeteries

of the Avar Period excavated so far in Hungary even in respect of the extremely low number of graves and that they are located in the cemetery map in groups that are in a distance from one another. We should think, therefore, that the two families have temporarily returned to the area of burying. Perhaps, owing to the highly developed animal husbandary at the Avars they turned out their animals to grass occasionally in that field, and buried in the same place their family members if they had died at the same time. Our supposition is supported by the topographical conditions of the area, as well: the burial place was not marshy, it suited therefore exactly for being used as a pasture.

To be sure, our working hypothesis may only mean an example for one of the burial rites of cemeteries from the Avar Period if we get similar further data from the analysis of other cemeteries, as well.

We wish to express our thanks to MIHÁLY KŐHEGYI for authorizing the publication of the cemetery map and for making the excavation records available for us.

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Acta Biologica Szeged 17 (1—4), pp. 209—221 (1971)

ANTHROPOLOGICAL INVESTIGATION OF THE CEMETERIES FROM THE 10TH AND 10—11TH CENTURIES, EXCAVATED AT SZARVAS

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(Received December 1st 1970)

Introduction

In the area of Ószőlő, lying east of Szarvas Békés county, the first excavations were carried out by Endre Krecsmárik, on the so-called Lómer hill and in Mihály Madlenka's land, about the year of 1909. The excavator established the cemeteries to be from the Hungarian Conquest Era (Krecsmarik, 1910). Júlia Kovalovszky also reported on the graves then found, as finds from the 10—11th centuries, and even on the settlement traces from the Arpadian Age, lying at the western and eastern ends of the sandhill which site — in her opinion — began to develop already in the 10th century (Kovalovszky, 1960). In another paper she describes a silver bracelet from the Age of the Conquest, found in the area of Szarvas, that supposedly came to light from the excavations carried out by Krecsmárik in Ószőlő (Kovalovszky, 1960a).

In 1960, István Dienes organized an excavation in Ószőlő, as well, namely in the area of the Velki hill (a household plot belonging to Petrovics's farm) that is probably identical with the Lómer hill mentioned above. He found the traces of an extensive Hungarian cemetery of the „common people" used, according to his establishment, continuously for a longer time, from the 10th till the 11th, and even till the 12th century (István Dienes: Report on the salvage excavation of a Hungarian common-people cemetery from the 10—11th centuries at Szarvas—Ószőlő; for placing at our disposal the above manuscript we should like to express our sincere gratitude to the author). In the investigated area the first result of the salvage of finds was the excavation of five graves. But in the course of further excavations there was found also another part of the cemetery having its origin supposedly in a later time, from where five further graves were excavated, anyway already damaged as the field there was trenched for a wineyard (Dienes, 1961).

Owing to the excavation of the archeologist Gyula Gazdapusztai, too, a cemetery from the 10th century was found in the downtown district of Szarvas (Szarvas — Lenin Street, later renamed Tessedik Street). The result of the excavation is: nine graves lying in one line of W—E orientation. Burying with horse occurred in three cases (Gazdapusztai, 1958).

We have elaborated the skeletal material of these two latter cemeteries, the material of which can be found in the Department of Anthropology in the Attila József University, Szeged. Because of the low number of the series, an

elaboration according to graves seemed to be practicable — publishing also the archaeological furniture. We have carried it out, following MARTIN's (1928) and LIPTÁK's (1962, 1965) method. In evaluating the trepanations, we have taken into consideration the monograph of NEMESKÉRI—ÉRY—KRALOVÁNSZKY (1960).

Metrical, morphological and taxonomical analysis

Szarvas—Ószőlő

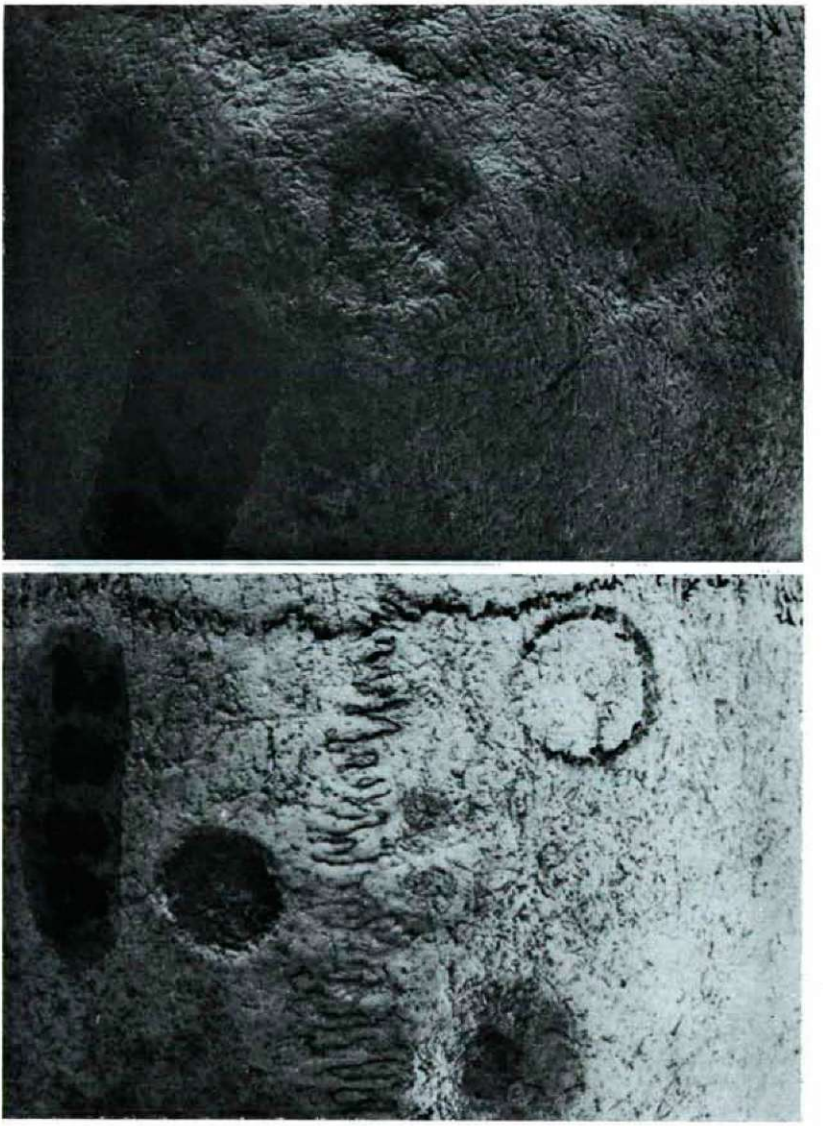
The anthropological material is in a good to medium state of preservation. The number of crania in good state of preservation — that are measurable — is seven, that of long bones in good state is five. An information is given in Table 1 about the state of preservation of the material and the connection between sex and age.

Table 1. Szarvas—Ószőlő: Skeletal material of the cemetery from the 10—11th centuries

Material character		Inf. II.	Ad.	Mat.	Together
In good state of preservation (measurable)	Males	—	1	3	4
	Females	—	1	1	2
	Of undetermined sex	1	—	—	1
	Together:	1	2	4	7 (63,64%)
Fragmentary (non-measurable)	Males	—	—	2	2
	Females	—	—	—	—
	Of undetermined sex	1	1	—	2
	Together:	1	1	2	4 (36,36%)
	Total:	2	3	6	11

Grave 1: Inventory number 2826. Calotte in good state of preservation and fragmentary skeleton. Male, maturus. The cranium is mesocranic. Norma verticalis: ovoid; glabella: 2; forehead is steep, eurometopic. Norma occipitalis: tent-shaped; protuberantia occipitalis externa: 1; processus mastoideus: medium. Lambdaregion: flat. On the os parietale three symbolic trepanations are to be seen. The site of the middle one is on the sutura sagittalis, in zone I named by Nemeskéri and co-workers, while those of the two extreme ones are in zones IIIa and IIIb that are the left, resp. right parietal bones at the calotte. All of them are circular but of different size. The one belonging to zone I is the largest and deepest, with a diameter of 15 mm. The one belonging

Plate I



a. Szarvas—Ószőlő, 10—11th century
Grave 1. Trephined skull.
b. Szarvas—Ószőlő, 10—11th century
Grave —. Trephined skull.

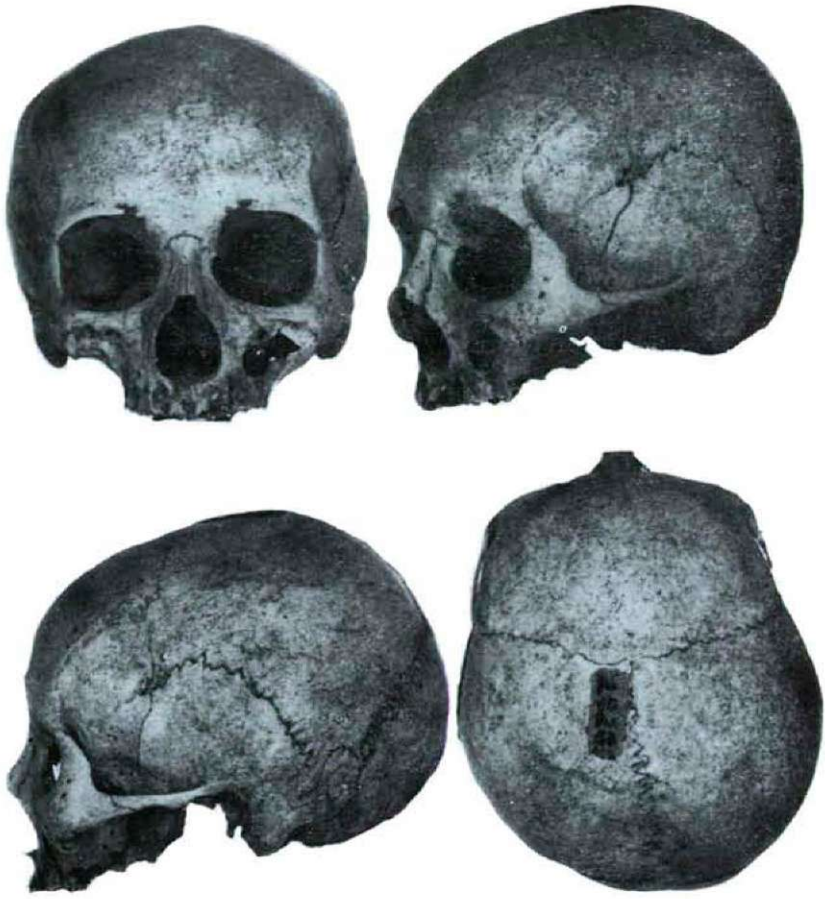


Fig. 1. Szarvas—Ószőlő, 10—11th century
Grave 3. Female, p—x

to zone IIIa is smaller as compared to the former one, with a diameter of only 10 mm. The one belonging to zone IIIb is the smallest, shallowest, and its diameter cannot be determined. All the three trepanations touch the tabula externa (Plate Ia).

Archeological furniture: Horse bones.

Grave 2: Inventory number 2827. Fragmentary pelvis and humerus of an adult of undetermined sex. It is a heavily disturbed grave.

Archeological furniture: three two-parts pendants and two round buttons (one of them is probably the upper part of the two-part pendant).

Grave 3: Inventory number 2828. Cranium and skeleton in a state of good preservation. Adult female. The cranium is brachycranic, orthocranic, tapeinocranic and aristencephalic. Norma verticalis: sphenoid. The forehead is steep, stenometopic. Glabella: 2. Norma occipitalis: house-shaped; protuberantia

occipitalis externa: O; processus mastoideus small. The upper-face is leptene; fossa canina: 2. The orbit is roundish, hypsiconch; the nose in moderately protruding, straight, leptorrhine. Nasal spine: 3; facial profile: orthognathous; alveolar prognathism: 2. Mandible is small, gracile. Her stature is tall, 160 cm. Taxon: p—x (Fig. 1).

Archeological furniture: 2 species simple bronze lock-rings.

Grave 4: Inventory number 2829. Fragmentary cranium and skeletal remains of a child. Inf. No archeological furniture.

Fig. 2. Szarvas—Ószőlő, 10—11th century
Grave 8. Male, m

Grave 5: Inventory number 2830. Fragmentary calotte and a skeleton in good state of preservation. Male, maturus. Greatest length of cranium: 180. Glabella: 3. His forehead is somewhat: curved; protuberantia occipitalis externa: 3; norma occipitalis: tent-shaped; processus mastoideus: medium. Stature: tall-medium, 168 cm.

Archeological furniture: a recessed small round button with gilded centre, a piece of an iron hoop of quiver, arrow iron, bone-cover of a bow.

Grave 6: Inventory number 2831. Calvarium and skeleton in good state of preservation. Female, matura. Cranium is mesocranic, hypsicranic, acrocranic, and euencephalic. Norma verticalis: ellipsoid. Her forehead is steep, eurymetopic. Glabella: 2; norma occipitalis: hause-shaped. Protuberantia occipitalis externa: 0; processus mastoideus is small. Mandible is medium high; the lambda-region is flat. Her stature is medium, 155 cm.

Archeological furniture: costated, S-ended lock-ring.

Grave 7: Inventory number 2832: Fragmentary cranium of a child (Inf. II).

No archeological furniture.

Grave 8: Inventory number 2833. Cranium and skeleton are in an excellent state of preservation. Male, adultus. Cranium is dolichocranic, orthocranic, acrocranic, and oligencephalic. Norma verticalis: pentagonoid. The forehead is somewhat curved, metriometopic; glabella: 4. Norma occipitalis: hause-shaped; protuberantia occipitalis externa: 1; processus mastoideus: medium. The face-cranium is mesoprosopic, mesene, the fossa canina: 3. The orbit is squared, mesoconch. The nose is chamaerrhine, medium protruding, straight. Facial profile is orthognathous; alveolar prognathism: 1. The mandible is small, gracile; in the lambda-region: divided os apicis. His stature is short-medium, 163 cm. Taxon: m (Fig. 2).

No archeological furniture.

Grave 9: Inventory number 2834. Calvarium in good state of preservation. Male, maturus. The cranium is mesocranic, hypsicranic, metriocranic and euencephalic. Norma verticalis: pentagonoid. His forehead is somewhat curved, metriometopic; glabella: 3. Norma occipitalis: house-shaped; protuberantia occipitalis externa: 0; processus mastoideus: small. Upper-face: euryene; fossa canina: 2. The orbit is squared, hypsiconch. The nose is medium protruding, straight, mesorrhine, the facial profile is orthognathous; alveolar prognathism: 1. Taxon: m—x (Fig. 3).

No archeological furniture.

Grave 10: Inventory number 2835. Cranium and skeleton in an excellent state of preservation. Male, maturus. Cranium is dolichocranic, orthocranic, metriocranic and aristencephalic. Norma verticalis: pentagonoid. His forehead is somewhat curved, sutura metopica, eurymetopic; glabella: 4. Norma occipitalis: house-shaped; protuberantia occipitalis externa: 0; processus mastoideus: medium. The face-cranium is mesoprosopic, mesene, the fossa canina is of degree 4. The orbit is mesoconch, squared. The nose is mesorrhine, medium protruding, straight. The facial profile is orthognathous, alveolar prograthism: 2, the nasal spine is of degree 3. The mandible is high and strong. The lambda-region is flat, sutural bones at the lambda-region. His stature is medium, 166 cm. Taxon: n (Fig. 4).

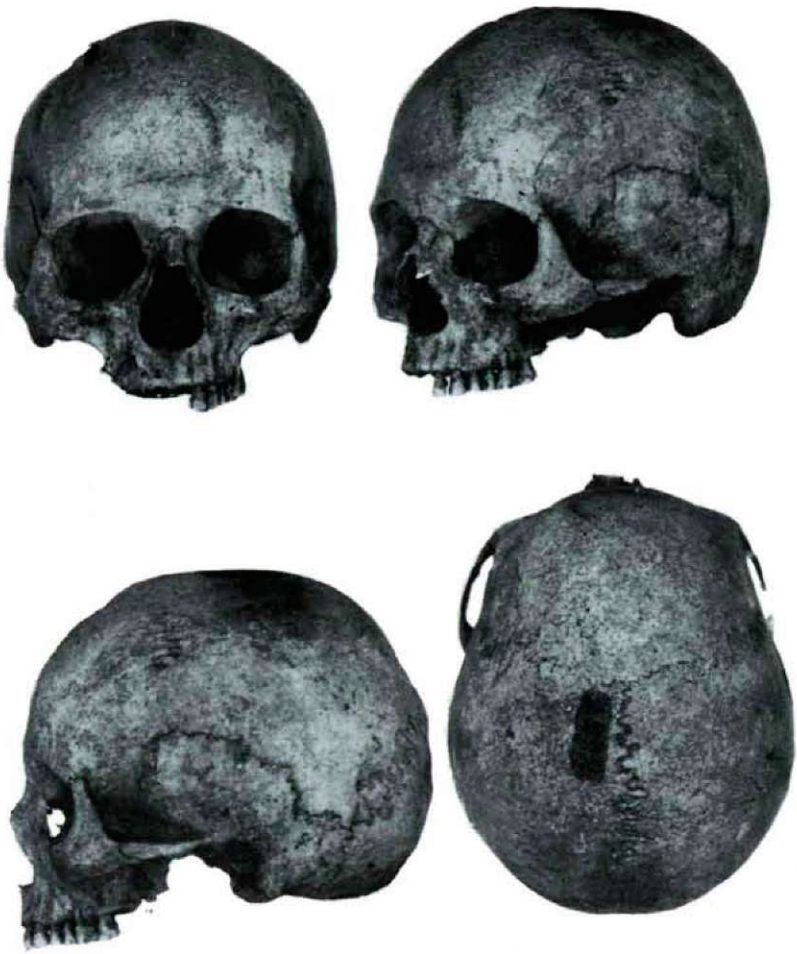


Fig. 3. Szarvas—Ószőlő, 10—11th century Grave 9. Male, n—x

No archeological furniture.

Inventory number 2836. (Stray find). Calvarium in good state of preservation. Male maturus. The cranium is mesocranic, chamaecranic, tapeinocranic, and euencephalic. Norma verticalis: ovoid. His forehead is somewhat curved, metriometopic, sutura metopica; glabella: 3. Norma occipitalis: house-shaped; protuberantia occipitalis externa: 0; processus mastoideus: medium. The upper-face is mesene; fossa canina: 2. The orbit is squared, hypsiconch; the nose is somewhat protruding, leptorrhine. Nasal spine: 3. Facial profile: orthognathous; alveolar prograthism: 1. The lambda-region is flat. Taxon: n—x (Fig. 5). On the calvaria three symbolical trepanations can be seen. All the three are round. On the right os parietale, near the sutura coronalis, a round engraving appears, belonging to zone IV. b. Its diameter is 20 mm.

The second one can be seen similarly on the right os parietale, its diameter is 10 mm, touching the tabula externa, and can be found in zone II. a. On the left os parietale there may be observed the third one, also in zone II. a., with 17 mm diameter. The intrusion took place till the diploe substance. The three trepanations most probably have been made in three different occasions (Plate I. b).

Fig. 4. Szarvas—Ószőlő, 10—11th century Grave 10. Male, n

Szarvas — Tessedik Street

The material of the seven graves at our disposal is very fragmentary. Here we omit to publish any archeological furniture, having at our disposal no documentation in detail.

Fig. 5. Szarvas—Őszőlő, 10—11th century
Grave —. Male, a—x

Grave 2: Inventory number 2819. A cranium of medium state of preservation. Male, maturus. The cranium is hyperbrachycranic. Norma verticalis: ovoid. The forehead is curved, stenometopic. Glabella: 3; norma occipitalis: house-shaped; protuberantia occipitalis externa: 3; processus mastoideus: strong. The face-cranium is hypereuryprosopic, euryene; fossa canina: 3. The orbit is squared, hypsiconch. The nose is leptorrhine. Alveolar prognathism: 2; mandible is medium high. Taxon: crC.

Grave 3: Inventory number 2820. Skeletal fragments of a child (Inf. I).

Grave 4: Inventory number 2821. Cranial fragments of a child (Inf. I).

Grave 5: Inventory number 2822. Fragmentary cranium and skeleton in medium state of preservation. Female, juv.-adulta. The cranium is hyper-

Table 2. Comparison of the anthropological finds of the Southern Hungarian Plain from the 10 th and the 10—11th centuries

Place of excavation	References	Number of crania suitable for metrical analysis	Major taxons
Orosháza-Dózsa co-operative farm, 10th century	Farkas—Lipták, 1965	Male: 4 Female: 1	Nordoid, Pamirian, Turanid
Békés-Povádzug, 10th century	Lipták—Farkas, 1967	Male: 2 Female: —	Cromagnoid-A, Mediterranean
Hódmezővásárhely-Nagysziget, 10—11th centuries	Farkas—Lotterhof—Marcsik, 1969	Male: 5 Female: —	Brachycranic, Mediterranean
Kübekháza-Újtelep, 10th century	Farkas—Lotterhof—Marcsik, 1969	Male: 4 Female: 3	Mediterranean, Nordoid, Turanid, Cromagnoid
Szabadkígyós-Homokbánya 10th century	Lotterhof, 1971	Male: 4 Female: 3	Mediterranean
Szabadkígyós-Pálliget, 10th century	Lotterhof, 1971	Male: 4 Female: 2	Cromagnoid-A, Nordoid
Szarvas-Ószőlő, 10—11 thcenturies	Lipták—Marcsik	Male: 4 Female: 1	Mediterranean, Nordoid, Pamirian

brachycranic, hypsicranic, tapeinocranic and aristencephalic. Norma verticalis: ovoid. The forehead is convex, metriometopic; glabella: 1. Norma occipitalis: bomb-shaped, protuberantia occipitalis externa: 0; processus mastoideus: small. The mandible is small. In the lambda-region: os apicis. Her stature is medium, 156 cm.

Grave 7: Inventory number 2823. Plagiocephalic cranium in medium state of preservation. Male, adultus. Glabella: 2; the forehead is somewhat curved; protuberantia occipitalis externa: 1; processus mastoideus: medium; spina nasalis anterior: 3; fossa canina: 3; the mandible is medium high.

Grave 8: Inventory number 2824. Fragmentary cranium. Female, adulta. The cranium is brachycranic. Norma verticalis: ovoid. The forehead is somewhat curved; glabella: 3. Norma occipitalis: house-shajed, protuberantia occipitalis externa: 2; processus mastoideus: strong. The mandible is medium high.

Grave 9: Inventory number 2825. Cranium is fragmentary. Female, matura. Glabella: 1; the forehead is steep. Fossa canina: 3; the nose is moderately protruding. The mandible is medium high.

General statements

The two cemeteries elaborated from the area of Szarvas, let us suppose two different populations, so much the more as the racial component Cromagnoid—C found in the Tessedik Street is absent from the material at Ószőlő. The cemetery in the Tessedik Street is a unilinear, rich cemetery of a clan (oral information by Dienes) but, owing to the low number and fragmentary character of its anthropological material, there can be drawn no considerable conclusions from it.

Comparing the series from Szarvas—Ószőlő with the South-Hungarian cemeteries recorded in Table 2 (FARKAS—LIPTÁK, 1965; LIPTÁK—FARKAS, 1967; FARKAS—LOTTERHOF—MARCSIK, 1969; LOTTERHOF, 1970) — of course, on the basis of the results of the taxonomical analysis — the material of Ószőlő is showing some difference. The Nordoid and Mediterranean components are predominant that is characteristic — according to LIPTÁK's monographs published in his comprehensive work (1970) and with co-workers (LOTTERHOF—MARCSIK—LIPTÁK, 1970) — of the anthropological feature of the common people. This result is supporting DIENES's supposition according to which the graves of Szarvas—Ószőlő are referring, on the basis of their archeological furniture, as well, to a cemetery of the common people.

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Acta Biologica Szeged 17 (1—4), pp. 221—229 (1971)

ANTHROPOLOGICAL INVESTIGATION OF THE SKELETAL MATERIAL FROM THE CEMETERY AT RÖSZKE-KÓSZÓ FARM FROM THE 14–15TH CENTURIES

EDIT LOTTERHOF

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(Received June 20, 1970)

In the spring of 1966, the Ferenc Móra Museum was informed that in the farm-yard of József Kószó, during the planting of trees, some human skeletons were found. The rescue excavation took place under the leadership of Alajos Bálint, director of the museum that time, between May 20th and June 6th 1966. On the basis of grave furniture, the cemetery may be ascribed to the 14—15th centuries (BÁLINT, 1967).

Most graves were of SW—NE orientation. Several overburyings were also found in the cemetery. In one case, the skeletons lay in eight layers one over the other; the majority of graves were disturbed.

In the course of the excavation some relics of a building that must have belonged to the foundation of a church, supposedly of a tower or steeple came to light. It will be the task of further excavations to decide whether or not the foundation exposed is really that of a mediaeval church and the graves are parts of a cemetery skirting that church.

The archaelogical elaboration of the cemetery has not yet taken place. We have deemed advisable, therefore, to specify the grave furniture, as follows. (The data are published on the basis of the record of the excavation prepared by Alajos Bálint — and I wish to thank him sincerely here for making them available to me.)

Grave No. 9: Iron object, coffin-nails
Grave No. 15: Glass bottle of spherical form
Grave No. 16: Coffin-nail, scattered fragments of a plate-like girdle-set
Grave No. 18: Bronze buttons
Grave No. 19: Ring
Grave No. 23: Coffin-botton
Garve No. 27: An oblon bronze clasp with plate, a girdle set with the remains of a leather belt
Grave No. 30: Girdle relic in bad condition
Grave No. 31: Necklace with pearls
Grave No. 35: Bronze „seal-ring"
Grave No. 39: Horse's canine
Grave No. 54: Bronze buttons
Grave No. 60: Girdle set lathe-turned of bone.

During the excavation, 63 graves were opened but a number of times it occurred that in one grave the bone relics of more than one individuals were

found. Therefore, the bone relics of altogether 67 individuals have been rescued.

During elaboration I followed the MARTIN's method (MARTIN—SALLER, 1957).

48 per cent of the material was fragmentary, unfitted for metrical analysis, 52 per cent of it is in good condition. 29 per cent of the material in good condition was (10 male), 37 per cent (13 female) and 34 per cent (12 infants and juveniles). Some data concerning the relation of sex and age, as well as the condition of the material are included in Table 1.

The general characterization of the series, making use of the data shown in Tables 2 and 3, is as follows:

Males: Cranium is mesocranic but brachycranic and hyperbrachycranic are also found, the indices being hypsicranic, tapeinocranic, resp. metriocranic. The cranial autline is in vertical norm pentagonoid but ovoid cranial outlines can also be found. On the basis of the transversal-frontoparietal index, the forehead is generally stenometopic, the glabella being, as a rule, of third degree. The cranial capacity is euencephalic.

The facial cranium is, on the basis of facial index generally mesoprosopic, the upper face mesene. The fossa canina is slight, or medium depth. The orbit is meso-hypsiconch, the nose is leptorrhine, the palate is leptostaphyline. Alveolar prognathism is generally absent or not more than moderate. On the basis of the total facial index, the face orthognathous.

Females: Cranium is brachycranic, with a considerable number of hyperbrachycranic elements, with hypsicranic, metriocranic, or tapeinocranic indices. The cranial outline in the vertical norm is pentagonoid but ovoid cranial outlines are also present. The forehead is, on the basis of the transversal-frontoparietal index metriometopic, or eurymetopic but like in males, stenometopic foreheads can be found too. The cranial capacity is — like in males — euencephalic.

The facial cranium is — distinct from that of males — generally euryprosopic. On the basis of upper facial index, the face is — like that of males — mesene. The fossa canina is slight, or of medium depth. The orbit is mesoconch, the nose is leptorrhine, the palatale is brachystaphyline. Alveolar prognathism is generally absent or moderate. On the basis of the total facial index, the face is mostly orthognathous.

The stature of males, as well as that of females, varies between large intervals, but at any rate, a medium stature is characteristic. Tall statures also occur in both sexes.

Between the metrical characteristics of both sexes there in no considerable difference. Differences appear only when considering the cranial and facial indexes.

Anatomical variations are apparent in several crania. In males, there occurred in one case from ten metopic suture (grave 28), os epiptericum dextrum (grave 39), torus palatinus sagittalis (grave 62) and suture bones (grave 39). In females, there could be found in one case from thirteen os epiptericum dextrum (grave 52), in three cases os epiptericum sinistrum (graves 52, 59, 9), in three cases torus palatinus sagitalis (graves 7, 52, 63), in one case os apicis lateralis sinistri et dextri (grave 52), and in one cranium suture bones (grave 52). In males one, in females two plagiocephalic crania found.

Table 1. Anthropological material of the cemetery at Röszke from the centuries 14—15th

Characterisation of the material		Inf. I.	Inf. II.	Juv.	Ad.	Mat.	Sen.	Total No. pc.
Fragmentary (unmeasuered)	Males	—	—	—	6	5	—	11 (35)
	Females	—	—	—	5	1	—	6 (18)
	Undeterminable	9	3	3	—	—	—	15 (47)
	Total:	9	3	3	11	6	—	32
Well preserved (measured)	Males	—	—	—	4	5	1	10 (29)
	Females	—	—	—	9	4	—	13 (37)
	Undeterminable	4	6	2	—	—	—	12 (34)
	Total:	4	6	2	13	9	1	35
	Sum-total:	13 19 pc.	9 13 pc.	5 8 pc.	24 36 pc.	15 22 pc.	1 2 pc.	67

Table 2. Distribution of the principal metrical characters

Characters			Males N	Males pc.	Females N	Females pc.	Total N	Total pc.
8:1 Cranial index	Mesocranic	75,0—79,9	3	(37,5)	2	(16,7)	5	(25,0)
	Brachycranic	80,0—84,9	2	(25,0)	6	(50,0)	8	(40,0)
	Hyperbrachycranic	85,0—89,9	3	(37,5)	4	(33,3)	6	(30,0)
	Total:		8		12		20	
17:1 Lenght-height index	Orthocranic	70,0—74,9	3	(37,5)	3	(27,3)	6	(31,6)
	Hypsicranic	75,0—x	5	(62,5)	8	(72,7)	13	(68,4)
	Total:		8		11		19	
17:8 Breadth-height index	Tapeinocranic	x—91,9	3	(42,9)	5	(41,7)	8	(42,1)
	Metriocranic	92,0—97,9	3	(42,9)	7	(58,3)	10	(52,6)
	Acrocranic	98,0—x	1	(14,2)	—		1	(5,3)
	Total:		7		12		19	
9:8 Frontoparietal index	Stenometopic	x—65,9	5	(55,6)	3	(27,2)	8	(40,0)
	Metriometopic	66,0—68,9	3	(33,3)	4	(36,4)	7	(35,0)
	Eurometopic	69,0—x	1	(11,1)	4	(36,4)	5	(25,0)
	Total:		9		11		20	
47:45 Facial index	Hypereuryprosopic	x—79,9	—		1	(20,0)	1	(10,0)
	Euryprosopic	80,0—84,9	1	(20,0)	3	(60,0)	4	(40,0)
	Mesoprosopic	85,0—89,9	3	(60,0)	1	(20,0)	4	(40,0)
	Leptoprosopic	90,0—94,9	1	(20,0)	—		1	(10,0)
	Total:		5		5		10	
48:45 Upper facial index	Euryene	45,0—49,9	1	(14,3)	2	(25,0)	3	(20,0)
	Mesene	50,0—54,9	6	(85,7)	6	(75,0)	12	(80,0)
	Total:		7		8		15	

Characters			Males N	Males pc.	Females N	Females pc.	Total N	Total pc.
52:51 Orbital index	Chamaeconch	x—75,9	2	(22,2)	3	(33,3)	5	(27,8)
	Mesoconch	76,0—84,9	4	(44,5)	5	(55,6)	9	(50,0)
	Hypsiconch	85,0—x	3	(33,3)	1	(11,1)	4	(22,2)
		Total:	9		9		18	
54:55 Nasal index	Leptorrhine	x—46,9	7	(77,8)	4	(50,0)	11	(64,8)
	Mesorrhine	47,0—50,9	1	(11,1)	2	(25,0)	3	(17,6)
	Chamaerrhine	51,0—57,9	1	(11,1)	2	(25,0)	3	(17,6)
		Total:	9		8		17	
63:62 Palatal index	Leptostaphyline	x—79,9	5	(83,3)	1	(33,3)	6	(66,7)
	Brachystaphyline	85,0—x	1	(16,7)	2	(66,7)	3	(33,3)
		Total	6		3		9	
38. Cranial capacity		Males / Females						
	Euencephalic	1301—1450 / 1151—1300	5	(71,4)	8	(72,7)	13	(72,2)
	Aristencephalic	1451—x / 1301—x	2	(28,6)	3	(27,3)	5	(27,8)
		Total:	7		11		18	
72. Total facial index	Mesognathous	80°—84°	1	(16,7)	2	(28,6)	3	(23,1)
	Orthognathous	85°—92°	5	(83,3)	5	(71,4)	10	(76,9)
		Total:	6		7		13	
Calculated stature		Males / Females						
	Short	150—159,9 / 140—148,9	2	(10,5)	—		2	(5,4)
	Short medium	160—163,9 / 149—152,9	3	(15,8)	2	(11,1)	5	(13,5)
	Medium	164—166,9 / 153—155,9	6	(31,6)	8	(44,4)	14	(37,8)
	Tall medium	167—169,9 / 156—158,9	3	(15,8)	3	(16,7)	6	(16,2)
	Tall	170—179,9 / 159—167,9	5	(26,3)	5	(27,8)	10	(27,1)
		Total:	19		18		37	

Plate I. Röszke—Kószó farm, 14—15th century Grave 1. p—x, (Fem.)

Plate II. Röszke—Kószó farm, 14—15th century Grave 39. crB—x, (Male)

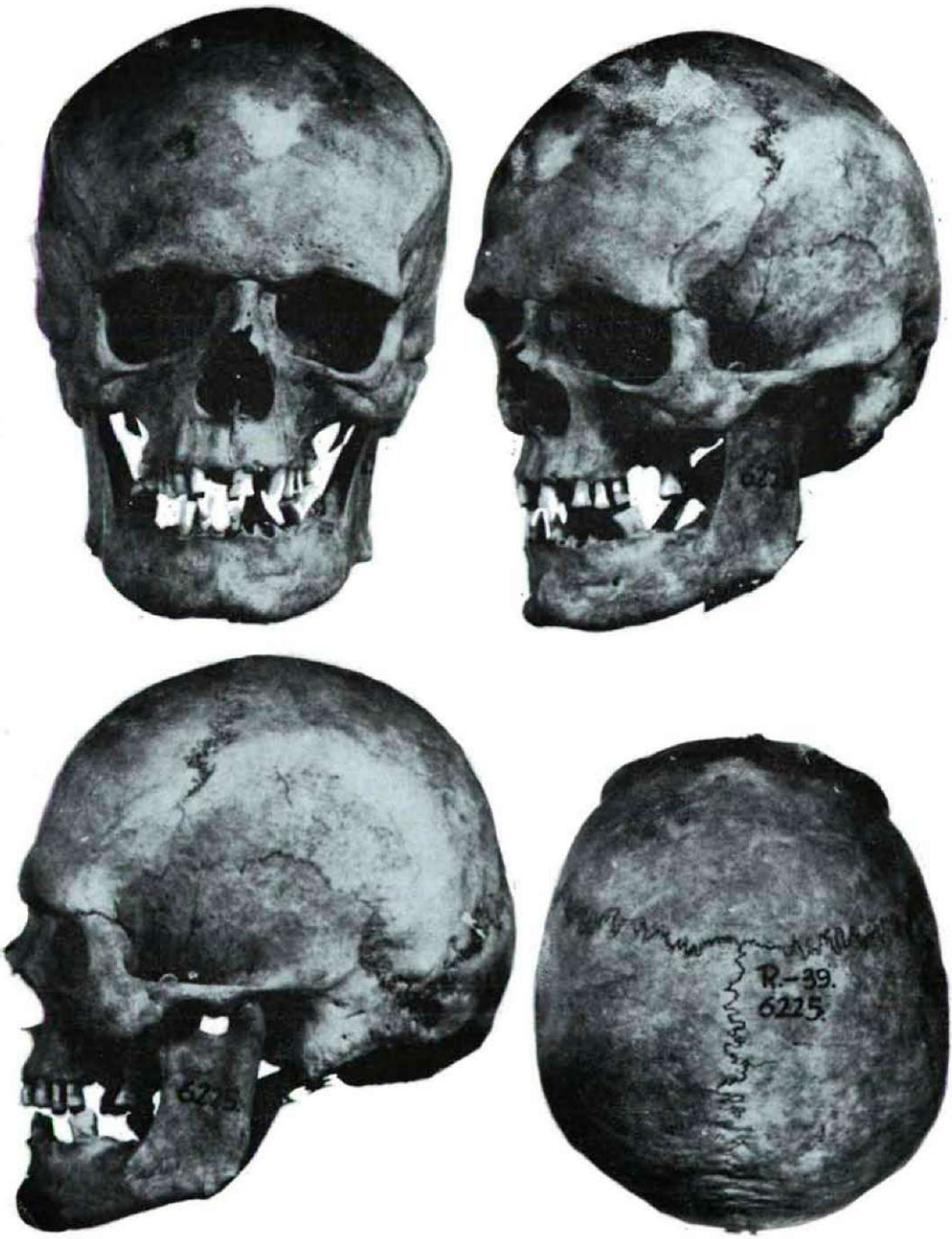

Table 3. Distribution of morphological characters

Characteristics		Males		Females		Together	
		N	pc.	N	pc.	N	pc.
Norma verticalis	Pentagonoid	1	(20)	6	(55)	7	(35)
	Ovoid	3	(60)	4	(36)	7	(35)
	Sphenoid	1	(20)	1	(9)	2	(10)
	Total:	5		11		20	
Glabella	Broca 1	1	(10)	6	(46)	7	(30)
	Broca 2	3	(30)	7	(54)	10	(44)
	Broca 3	5	(50)	—		5	(22)
	Broca 4	1	(10)	—		1	(4)
	Total:	10		13		23	
Fossa canina	2. Slight	5	(56)	4	(44)	9	(50)
	3. Medium	4	(44)	4	(44)	8	(44)
	4. Deep	—		1	(12)	1	(6)
	Total:	9		9		18	
Alveolar prognathism	1. Absent	4	(44)	3	(33)	7	(39)
	2. Moderate	4	(44)	4	(44)	8	(44)
	3. Pronounced	1	(12)	2	(23)	3	(17)
	Total:	9		9		18	

I have perfomed the taxonomical analysis according to P. LIPTÁK's method (LIPTÁK, 1969), with his help, for which I express my thanks to him.

Both in males and females only a rather low number of crania was suitable for taxonomical analysis in males seven, in females eight. According to the result of the taxonomical analysis, in males the following characteristic ensembles can be demonstrated: nordoid, cromagnoid and brachycranic elements (Plate I). Inside the brachycranic group of females, the occurrence of Pamirian race is more frequent. Within the brachycranic group, the cromagnoid race is also represented revealed by the presence of the eurymetopic frontoparietal index (Plate II).

Owing to the low number of cases in this meterial, I refrain from drawing far-reaching conclusions.

Comparing the mediaeval population at Röszke on the basis of the result of the taxonomical analysis, with other series, we find that in relation to the population of Baja—Pető in the 11th—16th centuries (LOTTERHOF, 1968) a difference is revealed owing to the predominance of Mediterranean elements there. In order of importance, that is followed by a high number of brachycranic elements. A comparison is rather difficult as in the case of Baja—Pető, the separation of Mediaveal graves from those of the Arpadian Age did not take place

archaeologically; the brachycranic elements came most probably from the mediaeval graves.

In the case of the similarly mediaeval cemetery at Mohács—Csele (NEMESKÉRI—DEÁK, 1965), the comparatively high number of brachycranic elements can also be demonstrated.

In the populations originating from the Transdanubian Fonyód (DEZSŐ et al., 1963) the brachycranic elements lose importance.

In mediaeval cemeteries anthropological evaluations have been carried out only in a few cases, therefore no far-reaching should be drawn conclusions. On the basis of data from other cemeteries we know that in the Middle Ages a pronounced brachycephalic procedure took place wich is further verified by this population at Röszke, although their case number is low.

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